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REPORT

OF THE

COMMISSIONER OF AGRICULTURE

FOR

THE YEAR 1879.

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FORTY-SIXTH CONGRESS—SECOND SESSION.

IN THE HOUSE OF REPRESENTATIVES, *May* 31, 1880.

The following resolution, originating in the House of Representatives, has this day been concurred in:

Resolved by the House of Representatives (the Senate concurring), That there be printed three hundred thousand copies of the Annual Report of the Commissioner of Agriculture for eighteen hundred and seventy-nine; two hundred and fourteen thousand copies for the use of members of the House of Representatives, fifty-six thousand copies for the use of members of the Senate, and thirty thousand copies for the use of the Department of Agriculture.

Attest: GEO. M. ADAMS, *Clerk.*

TABLE OF CONTENTS.

LIST OF ILLUSTRATIONS.

REPORT

OF

THE COMMISSIONER OF AGRICULTURE,

FOR THE YEAR 1879.

SIR: I have the honor to transmit this my third annual preliminary report of the agricultural condition of the country and of the work in hand and accomplished by the department during the past year.

At this time I recall with satisfaction the encouragement you gave when I assumed the duties of Commissioner to the proposed attempt to stimulate the manufacture of sugar from any and every source, so that the production within the boundaries of our own country should at least equal the home consumption. Reporting progress as the result of the efforts of this department in this direction, it is not too much to say that the success attending the manufacture of cane-sugar from sorghum and maize will mark the year 1879 as an important epoch in the agricultural progress of our people.

With the knowledge that during the past summer and fall sugar of good quality has been profitably made from Texas to Northern Minnesota from the "Minnesota early amber" cane (the seed of which was widely distributed by the department;) that sirups weighing 12 pounds to the gallon, at least one-half of which was crystallizable cane-sugar, was made and can be again made in nearly every State in the Union by farmers with ordinary and inexpensive machinery at a cost of 16⅔ cents per gallon, and with the knowledge that by means of larger and better appointed mills, that need not cost to exceed $10,000, sugar and sirup have been made the past season from sorghum by the car-load, which commanded the highest market price; it is not too much to assert, that, as a result of the work of this department, which has constantly before it the duty of accomplishing all that may be done to increase or multiply those products of the soil which constitute the wealth and sustain the manufactures and commerce of the country, a new industry has been fairly established, the importance and significance of which it is difficult to realize. With this and a knowledge of the work of the division of chemistry during the past season (a short statement of which will form part of this report), I am warranted in asserting that it has been finally and practically proved that one of the most important, expensive, and indispensable requisites of modern life can be profitably grown where heretofore it was supposed not possible to produce it; that it can be manufactured in quantities sufficient to meet any

demand likely to occur, at a remunerative rate even if the price should fall one-third below what it now is, and that the smallest farmer as well as the largest planter can profitably engage in its production; and this in no limited area of country, but in whatever place maize can be grown successfully; for there sorghum of some variety will grow, and it will flourish and mature its juice and seed in much of our soil in which maize is by no means a certain crop.

Several attempts to make sugar from beets in Illinois, Wisconsin, and California having been abandoned as unprofitable, and all attempts to make a merchantable sugar from sorghum having failed up to 1877, it became a settled opinion that only from tropical cane and the sugar maple could sugar be profitably made in the United States. The maple groves found scattered along a narrow strip of our northern border were and are fast disappearing, and the amount of sugar, at any time not very large, was in the census of 1870 reported at 28,443,645 pounds, and the molasses at 921,057 gallons.

It is now less, and is an inconsiderable factor in the problem. The manufacture of sugar from the tropical cane was confined to a narrow belt of country bordering the Gulf of Mexico, which produces an amount of sugar averaging for twenty years past 1,000 pounds per acre. The total production of this strip last year was about 250,000,000 pounds, while our importation from abroad was 1,741,650,000 pounds of sugar, beside molasses, melado, and other forms of sucrose, and being about 300,000,000 pounds increase over the importation of 1877–'78 (fiscal year).

The Department of Agriculture has done what was possible to encourage the production of sugar from the tropical cane as well as from beets and other plants, and there has been a large increase in area and in production of sugar from this source during the past two years; but the increased demand has far outstripped the increased production.

The consumption of sugar per capita of our people is about 40 pounds per annum at present, and with cheap, pure, healthful home-grown sugars the consumption per capita would increase to 60 or 80 pounds.

Fifty millions of people would consume at 60 pounds each, which it is said the English people consume, annually 3,000,000,000 pounds of sugar, worth at 6 cents $180,000,000, or at 10 cents, which is the price at which the Crystal Lake sorghum sugars of Weidner & Co. were sold this year, $300,000,000.

In reflecting upon this sugar problem, some two years since, it appeared to me that many years must pass before we could hope for a full supply of sugar from tropical canes grown on our own soil. The broken levees of the Mississippi River must be rebuilt, and the ruined plantations restored; the demoralized labor system of the South reconstructed and the disheartened land-owners encouraged; the mechanical must be, in part, divorced from the agricultural interest, and a co-operation of labor and capital must be established with confidence restored, before any very great and permanent increased production of sugar could be

looked for from the cultivation of tropical cane. Then again the plant itself belonged to a tropical country, and refused to ripen its seed in Louisiana, never even maturing the whole extent of stalk grown.

All these considerations combined to make a discouraging outlook for the home production of sugar from tropical cane within a period of time which would afford any relief to the then depressed condition of our industries.

It was with much gratification, therefore, that I first saw a specimen of well granulated sugar made from sorghum, and exhibited at the Minnesota State Fair.

After a thorough examination of the attempts to produce sugar from sorghum in this country, and also after a chemical examination in the laboratory of the juice of this particular plant, it became apparent that this was a probable source of the immediate production of this much-desired article.

The first stalks of sorghum ever grown in this country, so far as I am informed, were planted by the Curator of the Botanical Gardens. This seed was obtained from Paris, as was also the seed which the Agricultural Department first distributed in the year 1856.

A more effective distribution, however, was made by the enterprising editor and proprietor of the American Agriculturist, Mr. Orange Judd, who sent out 25,000 packages of seed to the subscribers of his paper. In 1857 Mr. Leonard Wray came from England and brought with him sixteen varieties of African imphee or sorghum, which were planted in South Carolina and Georgia. Sorghum was thus introduced and was largely grown in almost every State in the Union. During the war of the rebellion it was particularly valuable to the people of the Southern States, and was the only adequate means of obtaining their "sweetening." Isolated attempts were made in Ohio and elsewhere to granulate the juice of the varieties then in cultivation, but without such success or profit as would warrant a continuation of the efforts. In no instance did the result seem to be satisfactory, and the raising of sorghum was nearly abandoned in Ohio, and in other States was only cultivated for the sirup. When the discovery was made that the juice of the "Early Amber" cane seemed to be more pure than of others, and would, with careful attention, deposit a large amount of its sucrose in granular form, the department determined to make so far as possible a thorough examination of the different varieties of sorghum and test their relative merits and value as sugar-producing plants. This inquiry has been patiently and carefully followed from the season of 1877 to 1879, and the results have been eminently satisfactory, as will appear in remarks upon the work of the Chemical Division. It is sufficient to say in this place that the value of the work done during the past year by this division can not be overestimated.

Mention had been made, and it had been recorded and mostly forgotten, that sugar was obtainable from corn, pumpkins, melons, and other vegetables, but no thorough, careful, persistent experiment seems ever to have

been made (if we except that of Mr. F. L. Stewart, who was found among the mountains of Pennsylvania at work for some years in this direction under discouraging circumstances), having in view the determination of the commercial value of these and other plants, until this task was assigned to the Chemical Division of this department in 1878. In a letter from Abigail Adams to her husband, John Adams, September 24, 1777, she says:

An instance may be seen in the progress which is made in grinding cornstalks and boiling the liquor into molasses. Scarcely a town or parish within forty miles of us but what has several mills at work; and had the experiment been made a month sooner, many thousand barrels would have been made. No less than 80 have been made in the small town of Manchester. It answers very well to distill, and may be boiled down to sugar. There are two mills fitting up in this parish. They have three rollers—one with cogs and two smooth. The stalks are stripped of the leaves and tops, so that it is no robbery upon the cattle, and the juice ground out. 'Tis said four barrels of juice will make one of molasses, but in this people differ widely. They have a method of refining it so that it looks as well as the best imported molasses.

The following is an extract from the work of David Lee Childs on the culture of the beet and manufacture of beet-sugar:

Other plants usually grown in our soil are capable of furnishing sugar, and some of them may be found worth cultivating for that and accessory products.

We have tried Indian-corn stalks and the pumpkin, and have obtained from them good sugar and molasses.

Perhaps these crops may alternate advantageously with the beet. If the manufacture of sugar from the stalks of Indian corn can be reconciled, as we believe it may, with the maturity or near maturity of the ears, this source of saccharine may supersede the beet-root. The seeds of the pumpkin yield a fine sweet oil, but we have no means of judging what quantity of this product can be obtained from a given extent of land. If it should turn out satisfactorily in this respect, the pumpkin may one day overshadow the sugar-cane.

Here was the opportunity and it was at that time the duty of the government to assume the risk of failure and the expense and care of such scientific analyses and experimental trial as would have exhausted all resources before giving up even the hope of securing success in the profitable production of sugar, and thus retaining at home the millions of money that have since gone out to sustain and enrich other nations. The work that should have been done then has been undertaken now, with such imperfect means as were furnished; and notwithstanding the ridicule of the thoughtless, and the fears of hopeful friends, it has been steadily pushed forward to a satisfactory conclusion.

Many persons are preparing to imitate the example of F. A. Weidner & Co., of Chicago, and erect mills the coming season with vacuum pans, and centrifugal driers in which the work will be done by steam and of capacity sufficient to make a ton of sugar each day of twenty-four hours' work. Mills of this capacity will be needed in every county where sorghum is grown, and will not only be employed in the harvest season in milling the stalks of sorghum and corn direct from the field, but will also after harvest and during the winter take the product of the small open-pan mills (sirups weighing 8 to 12 pounds) and rework that in the vacuum pan and centrifugal, making sugar and sirup for the market.

CHEMICAL DIVISION.

The work accomplished in the Chemical Division up to the 27th of May, 1879, was included in the annual report for 1878. From that date to the present time there have been made—

First. Ninety-one miscellaneous analyses, including soils, waters, fertilizers, clays, ores, marls, and other mineral substances.

Second. Thirty approximate analyses of various food and medicinal materials.

Third. Two hundred and seventy-four analyses of various sugar-yielding plants and their juices.

Fourth. Five experiments in alcoholic distillations from the refuse of sugar-manufacture, and twenty-eight experiments in making sugar from various sugar-yielding plants—in all thirty-three.

The experiments entered upon for the purpose of determining the amount of sugar in the juice of the several varieties of sorghum, of the stalks of maize and of pearl millet, give results which enjoin their earliest possible publication that they may reach the farmers for their instruction before the time for the spring planting arrives.

A fair conclusion from these investigations appears to be that there exists but little difference between the various kinds of sorghum as sugar-producing plants, and that the juice of each of them is at a certain period of its development nearly as rich as that of the best tropical sugar-cane grown in this country.

It is a matter also of extreme practical importance that it should be known that this period of maximum content of sugar is maintained for a sufficient time to enable the manufacturer to work up a large crop of stalks. Another result of this investigation has been to satisfactorily explain the cause of repeated failure in the production of sugar from certain plants during the past quarter of a century.

For the purpose of making clear the above points, a few of the results obtained by the chemist are appended. The varieties of sorghum canes subjected to this investigation were "Early Amber," "White Liberian," "Chinese," "Honduras," and "Pearl Millet."

	Development of plant.	Date of analysis.	Per cent. of water in stalk.	Per cent. of juice obtained.	Specific gravity of juice.	Per cent. of glucose in juice.	Per cent. of sucrose in juice.
Early Amber	Seed-head just out	July 18	82.70	34.6	1047	3.77	4.43
	Seed hardening	Aug. 16	80.07	32.7	1089	1.54	14.67
	Seed ripe, hard, dry	Sept. 16	73.20	22.9	1080	0.65	15.95
	After hard frost	Oct. 29	69.38	33.3	1088	1.10	17.00
Chinese	Seed-head just out	Aug. 6	83.99	32.7	1033	5.55	1.85
	Seed hardening	Aug. 19	78.77	29.0	1067	5.25	6.45
	Seed ripe, hard, dry	Sept. 13	71.27	28.1	1085	1.45	13.90
	After hard frost	Oct. 29	69.51	31.0	1076	1.85	13.15
White Liberian	Seed just in milk	July 26	79.32	38.5	1046	3.50	4.70
	Seed nearly ripe	Aug. 26	71.34	29.5	1082	1.40	13.70
	Seed ripe and hard	Sept. 27	71.00	21.2	1078	0.95	15.20
	After hard frost	Oct. 29	69.66	28.8	1081	2.10	13.09

	Development of plant.	Date of analysis.	Per cent. of water in stalk.	Per cent. of juice obtained.	Specific gravity of juice.	Per cent. of glucose in juice.	Per cent. of sucrose in juice.
Honduras	Seed-head not out	Aug. 12	84.00	34.4	1035	5.13	1.20
	Seed just in milk	Sept. 13	77.79	35.6	1055	3.80	8.40
	Seed hardening	Oct. 20	69.39	30.6	1079	1.30	15.10
	After hard frost	Oct. 29	71.42	34.5	1075	1.50	14.20
Pearl Millet	In blossom	Sept. 10	76.31	30.0	1035	1.60	1.90
	Suckering at top	Sept. 25	72.00	21.5	1054	1.10	8.70
	Leaves dying	Oct. 14	64.41	20.3	1068	2.00	11.30
	After hard frost	Oct. 29	72.54	22.0	1070	5.40	7.40
Louisiana Ribbon Cane Plant, 1879		Nov. 10	77.19		1057	1.21	12.47
Louisiana Ribbon Cane Plant, 1878		Nov. 10	81.77		1070	0.57	16.50
Do		Nov. 10	76.95		1065	1.23	14.31

Beside the above there were made very many examinations of other specimens of sorghum, and also of cornstalks.

These examinations confirm the general principle above stated, viz., the practical equality and great value of each variety of this plant.

In the following table is given the result of the analysis of each of the plants in four successive stages of development. It will be observed that the amount of glucose (or uncrystallizable sugar) diminishes and the amount of sucrose (or true cane sugar) increases up to a certain time in the development of the plant; that these plants differ widely as to the time when the sucrose is at its maximum, but are alike in this, that the maximum is obtained at about the same degree of the development of the plant, viz., at full maturity, as indicated by the hard, dry seed and the appearance of shoots or suckers at the upper joints of the stalk.

It is also to be observed that the heavy frost of October 24, which was sufficient to form ice half an inch in thickness in tubs of water, did not produce any marked diminution of sugar. Three varieties of sugar-cane received from Louisiana in excellent condition, and which doubtless fairly represent the average character of this famous sugar-plant, were analyzed and the analyses are embraced in this table for purposes of comparison.

Something over 23 tons of the stalks of corn, sorghum, and millett have been used in making investigations, the result of which has been not only to fully confirm the work of last year, but also to aid in the settlement of certain other questions of the highest practical importance.

In other cases it has been found that the quality of sirup obtained has been precisely such as the previous laboratory analyses of the juices used made probable.

The average of the nine best sirups obtained showed a percentage of cane sugar present equal to 92.7, being a loss of 7.3 of the amount originally present in the juice, while the average of the nine poorest, *i. e.*, containing the lowest percentage of cane sugar, showed a percentage of

cane sugar present equal to 90.1, a loss of 9.9 of the amount originally present in the juice.

This very satisfactory result, showing as it does conclusively the possibility of securing from the juices all the cane sugar present without a loss of more than 7 to 10 per cent., is of great importance in view of the fact that all these juices were evaporated in an open pan. A few of the experiments made give a reasonable basis for estimating the probable yield of sirup and sugar to the acre, and therefore an approximate estimate of the cost of producing sugar.

Below is the tabulated result of a few of the experiments from stalks grown upon the grounds of the department.

These stalks were grown in rows three feet apart, twelve to fourteen inches in the row, and although a good crop, there is no doubt that upon good land an equal yield to the acre could be readily obtained.

	Pounds stalks from acre.	Sirup obtained.	Sirup, juice at best.	Sirup, juice, 70 per cent.
Chinese sorghum	33,000	2,096	2,397	3,673
Liberian sorghum	33,727	2,472	2,609	3,783
Early Amber sorghum	32,415	2,190	2,615	3,661
Honduras sorghum	66,151	3,652	5,168	7,537
Pearl millet	65,000	1,846	3,128	4,865
Field corn	27,240	1,166	....	1,807

The first and second columns give the result actually secured, but the several juices were not in their best condition as compared with the results given in the first table. The third column is the amount which this same weight of stalks would have yielded had they been cut at the proper time. The juice obtained from the stalks by the imperfect means at the command of the department was a little more than one-half of the amount present in the stalks. The fourth column represents the results obtainable by the use of a mill that would have given 68 per cent. of the juice, a result which is possible and claimed as common by the manufacturers of the mills. There is no doubt that when the present industry shall have received the employment of the capital and scientific ability which has developed the beet-sugar industry, even these results, which may appear extravagant to many, will be equaled and probably surpassed.

Although as has been stated these sirups were obtained from stalks in which the maximum content of sugar had not been developed, yet they all crystallized well and yielded an excellent article of sugar.

The sugar had not been separated from the Chinese sorghum sirup, which gave 54.7 of sugar, nor from the field corn, which gave 39 per cent. of sugar.

The experiments with field corn are worthy of special notice, since the results secured are not only most surprising, but contrary to almost universal belief.

The corn-stalks were of three varieties, viz., Lindsay's Horse Tooth, White Improved Prolific, and White Dent, three coarse-growing white field corns. The stalks grew in drills three feet apart and about nine or ten inches in the row.

The ears were plucked after they had thoroughly ripened and the husks were dead and dry; the stalks, however, were yet juicy. The corn was plump and sound and yielded at the rate of 69.1 bushels of shelled corn, fifty-six pounds to the bushel, to the acre. The stalks were then topped, stripped, and crushed, and the juice proved to be the best yet obtained from corn-stalks at any period of growth or of any variety. It is exceedingly to be regretted that this department had not during the past season an opportunity to try these experiments in the large and practical way of field cultivation which would have been befitting the importance of the occasion. Not less than an acre, and preferably five acres, of each variety of sorghum and maize experimented with should be grown and its developments should be watched carefully with the aid of all the appliances of science, throughout the season and worked up at the proper time with the best machinery attainable, and it is hoped that a matter of so much importance will receive such attention at the hands of Congress as will enable the department to properly discharge its duties to the country in this regard.

With the present grounds and laboratory force at the command of the department this is impossible. The correspondence upon matters pertinent to the Chemical Division has increased so largely that with the present force it is impossible to give it the attention which it demands. The amount of work which has accumulated in advance of the means to accomplish it shows how promptly and gladly our people would avail themselves of the advantages which a proper enlargement of the division would afford. The legitimate work which has already accumulated and which is mapped out for the Chemical Division would employ the present force for years.

ENTOMOLOGICAL DIVISION.

On the retirement of Prof. C. V. Riley, May 1st, the department was fortunate in obtaining the services of Prof. J. H. Comstock, of Cornell University, concerning whom the President of the university, Hon. Andrew D. White, wrote:

> He seems to me in every respect fitted to discharge the duties usefully to the public service and satisfactorily to yourself. He has most thorough scientific attainments, great energy, pleasant address, excellent temper, and is certainly destined soon to be a recognized authority in his department throughout the world as he now is over a considerable part of this country. Nothing but a sense of duty to him leads me to write this letter. * * * As it is, I hope to reclaim him some day. As to character, temper, relations with scientific people, he is all that could be desired.

It is sufficient to say that Professor Comstock's studies have fitted him for the position, and under his direction the Entomological Division has made notable advance in its appropriate investigations, and thus far the high recommendation of President White has been entirely sustained.

The work of the Entomological Division during the year may be classified under four heads:

1. Finishing the investigation of insects injurious to the cotton plant, begun last year under special appropriation of Congress, and preparing an extended report upon its results.

2. Rearing to the perfect stage new or little known injurious insects for the purpose of gaining a knowledge of their habits and transformations which shall facilitate the suggestion of remedies.

3. The conducting of an extended correspondence relative to noxious insects.

4. The raising of different varieties of silk-worms with a view of experimenting: first, upon the most approved methods of rearing; and, second, upon food-plants, carefully comparing the Osage orange with the different varieties of mulberry. Also the distribution to all applicants.

The investigation of insects injurious to the cotton plant has been completed. Professor Comstock, having been engaged in this investigation from its beginning, was able to take charge of it without material loss of time. A trained observer was sent into the field early in May, where he remained until the middle of September, carrying on extensive experiments upon remedies and clearing up mooted points in the life histories of the cotton-worm and the boll-worm.

Work on this report has been rapidly progressing, and it is hoped and believed that the facts therein contained will enable the Southern planters to render these enemies to their staple crop sources of much less damage than heretofore.

As regards the rearing of new or little-known injurious insects, the division has studied since May 1 the following:

	Species.
Of insects infesting the apple	17
peach	7
orange	5
pear	2
grape	11
raspberry	1
strawberry	1
corn	3
cabbage	3
melon	1
tobacco	1
grasses	9
clover	36
pine	16
locust	15
oak	13
maple	3
miscellaneous shade-trees	15
Museum pests	7

Many of these insects are treated of in the annual report of the entomologist. Others will require the additional study of another season,

and the succeeding report will contain accounts of the observations. Insects injurious to agriculture are constantly making their appearance either through importation or by the sudden acquisition of destructive habits by species before considered innoxious; hence this branch of study requires of the division much time and attention.

The correspondence of this division has increased greatly during the past six months, and it is entirely beyond the power of the clerical force of the division to give that prompt attention to inquiries upon the subject of insects injurious to agriculture that come from all parts of the country.

During the latter part of last winter, twenty ounces of imported silk-worm eggs, the majority from Japan, and the rest purchased from reliable French dealers, were distributed among some fifty persons desirous of commencing silk culture. The reports so far received seem to demonstrate, beyond a doubt, the possibility of the successful culture of silk in almost every part of the country. Unskilled persons have, with the help and advice of the department, in nearly every instance brought a large proportion of the worms successfully to the spinning point.

Experiments conducted during April, May, and June, 1879, confirm the opinion that Osage orange is but little inferior to *Morus multicaulis* as silk-worm food; and the demonstration of this fact necessarily enlarges the possibilities of the industry in this country.

A correspondent writing from Bengal, India, and who has served an apprenticeship at silk raising in that country, with an additional experience of five years in the business, makes a proposition to the department to transport and acclimate the "Tusser" silk worm in the proper latitudes of this country, to the extent of one thousand pounds of cocoons, at a cost of about $550,000. This species of worm is indigenous to the province of Assam, in Bengal, where the British Government is giving much attention to silk culture, and is of a hardy nature and a most prolific spinner. The writer says: "If America can only secure to herself a fair start now in the 'Tusser' industry, she will add vastly by it to her manufacturing revenues." If furnished the means of naturalizing his favorite "Tusser" worm in America, he thinks success is certain. He adds, "With the Tusser worm fairly fixed in your vast continent, you might snap your fingers at all the silk-producing countries in the world."

While I cannot recommend the beginning of operations on so large a scale, the above is cited to give an idea of what persons of intelligence and experience in other countries are doing in silk culture, and would do to establish it here if encouraged. And it is believed this great industry may, by careful procedure, be gradually and economically established in many portions of the United States, with vast benefit to the inhabitants.

An entire reorganization of the entomological collection has been begun. A supply of new cases has been procured, and the collection is

being put into such form as shall best insure its preservation and accessibility.

Whenever, during the year, word has been received of any insect irruption of particular interest, an assistant has been sent to the spot to make observations, or a local observer has been employed, to insure a thorough investigation of causes and a more intelligent suggestion of remedies.

In addition to the usual work of the Entomological Division during the next season, a series of experiments will be instituted for the purpose of utilizing the knowledge obtained in applying remedies of various kinds. The results, with all known facts, will be collated into an accessible form for general distribution. This will be a work of considerable magnitude; but it is one which, if well done, will prove of the greatest benefit.

At present, what is known about remedies is scattered through the great number of published volumes and agricultural periodicals. Much of it is doubtless valuable, and much is worthless. It is proposed to critically try, so far as is possible, all of the more important remedies, and to publish in compact form the results.

The habits of and remedies for insects injurious to the orange will be made a special study. The numerous communications received from orange-growers in California and Florida upon this point during the past year have revealed the fact that here is an almost unexplored field to the economic entomologist, and that it is of the greatest importance that some earnest and intelligent work, backed by sufficient means, should be done in this direction at once.

It is designed to resume and continue upon a large scale the biological collection begun in 1876 and discontinued since then, which shall illustrate, when completed, the natural history and habits of all of the injurious insects of the United States; and also to make small biological collections, illustrating our more common injurious insects, for distribution to the agricultural colleges throughout the country, so far as the appropriations will admit.

The division has never been better prepared to do efficient work than at present; but several assistants and an additional clerical force are necessary to meet promptly the increased demands for information.

STATISTICAL DIVISION.

The arduous work of this division has been most vigorously prosecuted by the small force now at its disposal.

As will be observed by reference to the detailed report of the statistician, it has a very large and rapidly increasing correspondence, both foreign and domestic.

The number of correspondents is now considerably in excess of four thousand. They have been selected with an eye to their intelligence, experience, and general fitness for the duties which devolve upon them. Most of their communications consist of replies to queries propounded

by the department. These are first verified by the statistician by comparison with the most reliable data attainable from other sources, then classified and arranged in the tabulated form which the numerous accompanying tables present. Those relating to the growing crops are first compiled for issue in the Monthly Bulletin of the department. This is prepared by this division and widely disseminated through the mails and through the daily and weekly press, which are furnished with early copies. These crop reports, and, indeed, all the statistics of this department have become necessary not only to the producing agriculturists, but also to the middlemen and consumers, and under the untiring and careful supervision of the statistician and his painstaking assistants, are becoming noted for that accuracy which should characterize all statistical work. The labor involved is not only arduous, but of an intricate character. It requires discretion, judgment, and experience. It cannot be intelligently performed by novices, nor will it do to intrust it to those of careless or negligent habits, because slight errors in the calculations might prove injurious to some of the most important interests in the country. A liberal increase in the force of this division is very desirable. Each addition to the list of correspondents adds to the labor of this division and also augments the value of the crop reports in accuracy and reliability.

The frequent applications made to the department for statistical information by agents of foreign governments, by merchants, and by members of Congress, have all been promptly met in a satisfactory manner by the facts and figures collected and recorded.

The collection and tabulation of such statistics of European production as bear on our own markets have been made a subject of special care. The contrast presented as illustrated by these interesting and instructive tables will well repay the study necessary to digest the information conveyed.

Investigations regarding the "wages of labor" and the "value of farm lands" have been instituted and considerable progress made in their prosecution; but, owing to pressure of other duties and inadequacy of force, the work was necessarily suspended during several months.

As the value of farm lands is largely dependent on the price of labor for their productive cultivation, the average wages of labor becomes an important factor in successful agriculture as well as in the present and prospective money value of farms. It is clear that the taxes on an unproductive farm would soon consume its value. As production is impossible without labor, the cost of the latter becomes a vital point with the agriculturist. It will be possible to pursue these interesting investigations in a more thorough manner, and lay the results before the country in such a way as will, it is believed, be productive of many benefits, if the bill entitled "A bill to encourage inter-State migration," introduced by Hon. W. F. Sapp, of Iowa, at the second session of the

Forty-fifth Congress, and which, so far as known, was warmly approved of by members of Congress, shall become a law.

The report of crops for the year presents the same gratifying aspects as that of last year. Although the yield per acre in some instances is below that of 1878, the increase of area more than compensates for the declining average. As a whole, the wheat crop of the country is unprecedented in yield, being within a small fraction of fourteen bushels to the acre. The increase in area, some 2.3 per cent., is not so large as that reported last year. In the great wheat-growing States of the Northwest the same climatic influences that were so detrimental in 1878 were again felt this year, and the yield per acre in these States the present year shows little variation from that of its predecessor; while in the States contiguous to and bordering upon the Ohio River, but in which winter-sown wheat prevails, there was an extraordinary product. In the State of Indiana the yield was increased from sixteen bushels per acre to twenty and three-tenths. In fact, the crop in all the country was above the average, except in Texas and Kansas. California had a good crop, but not as large as in 1878. The acreage of corn was increased this year about three per cent. Drought in the South Atlantic and Gulf States was detrimental, but in those States bordering on the Ohio and Mississippi Rivers the season was favorable, and the yield was very large. The total product of corn in 1879 is some two hundred million bushels more than in 1878. This result is remarkable, as it is the fifth consecutive year of abundant crops.

The cotton crop, which is so important in its bearing on the prosperity of the country, because it furnishes one of the chief articles of foreign export, shows a slight decline from the yield of last year. As compared with 1878, which was the year of the largest production, the deficit will be, in round numbers, 290,000 bales.

In the product of other important crops there is no material change, except that the short yield of potatoes in 1878 is replaced this year with a full crop. Full details of the aggregate production of each of the principal crops, together with area planted and the estimated value of the same, will be found in the statistician's annual report.

His tables afford much general information useful to the thoughtful farmer in the handling and marketing of his crops. The average-price table, showing the difference in value between the market nearest his farm and in New York, Philadelphia, Baltimore, and Boston, acquaints him with the average cost of transportation, insurance, and commission from the point of production to that of consumption. The wages table is very instructive. It shows that ordinary farm-labor commands most in New England, where education is universal, and the laborers are consequently intelligent. This advance may be considered a premium on intelligence. In the South and West, while farm-labor is lower, being generally uneducated, that of the intelligent mechanic is considerably higher than it is in New England. This again may be considered

a premium on educated labor where that commodity is scarce. A careful examination of the wage-tables and of the price-list of breadstuffs and provisions in the different sections of the country will enable laborers to determine where toil is best rewarded, after deducting the cost of subsistence.

BOTANICAL DIVISION.

The following inquiries concerning the botanical collection of this department are sometimes made: What are they? What are their uses? And what are their needs?

The botanical collections consist of prepared specimens intended to represent every species of plant, shrub, or tree growing in the United States, and to some extent, also, the vegetable productions of other countries. They include also definite and authentic specimens of our forest woods and the more important fruits, cones, and seeds. The foundation of this herbarium was laid by the numerous collections made at different times by the government expeditions, as the expedition to Japan under Commodore Perry; the North and South Pacific exploring expeditions, Commodore Wilkes' expedition, the Mexican boundary survey, and the Pacific Railroad surveys.

The botanical collections made by most of these expeditions, after being properly investigated and described by those distinguished American botanists, Doctors Torry and Gray, were deposited with the Smithsonian Institution until the year 1869, when an arrangement was made between the Secretary of that Institution and the Commissioner of Agriculture by which the botanical collections were transferred to the Department of Agriculture, and committed to the care of a properly-qualified botanist connected with the department.

This arrangement was entered into for two purposes: first, the Agricultural Department needed the services of a botanist to give attention to critical questions which were continually arising as to the nature and qualities of certain plants which attracted the attention of agriculturists in various parts of the country; and, secondly, the large and important botanical collections of the Smithsonian Institution could not be made practically useful without the employment for a number of years of a competent botanist to arrange and classify them, and make them available for purposes of study and reference. The opportunity thus presented itself of uniting the practical wants of the Department of Agriculture with the interests of science and education as repre sented by the Smithsonian Institution.

Since the transfer above mentioned large additions have been made by the recent government surveys, by some purchases, and by some exchanges with foreign governments. The herbarium has been transferred to more commodious rooms, and many new cases have been provided, so that all the specimens are easy of access and measurably well displayed.

This collection, like all museum collections, has an educational character. The rooms of this division are visited by thousands of persons, who have the opportunity of examining the vegetable productions of the country, and to some extent comparing them with those of other countries. Very few of these visitors will fail to gather some items of information which will be a source of pleasure and instruction to them, will be diffused by them, and thus have a beneficial influence on the popular intelligence.

The department receives from foreign nations by way of exchange and otherwise many valuable specimens of woods and plants, which are arranged, verified, and classified by the botanist of this division; duplicates are distributed to State agricultural colleges and other institutions of learning, not only of these, but also of American forest woods. These distributions have been highly appreciated, and are useful in promoting the higher education which is demanded by the times for intelligent agriculture.

This botanical collection has also a special scientific value. It is the custom of all enlightened countries to collect at government centers specimens of the productions of the country, both for practical purposes and for the promotion of scientific knowledge. These museums and herbariums bring together a vast mass of material which men of science investigate and classify, and add to the stock of human knowledge.

Though much of this knowledge may be technical, and useful chiefly to specialists, it is necessary to the full development of those sciences which have so greatly advanced the culture and prosperity of mankind. It is hardly necessary to say that it is the duty of the government to advance the interests of education and science; and assuredly there is no other department of the government where botanical science can be more appropriately fostered and cared for than the Department of Agriculture. Here is the place where information respecting every vegetable production of our vast country should be obtainable. Among the thousands of visitors to the national capital are those who are interested in education and science, who will gladly avail themselves of the opportunity here offered to examine the productions of the entire country and foreign states.

Although much of the botanical material is special and scientific, it should not be forgotten that it is the special knowledge of the botanist which enables him to make those critical determinations respecting species, and respecting the nature, properties, and value of the plants, some of which are supposed to have valuable medicinal properties, some which demand investigation on account of their injurious or poisonous qualities, others for their economic value as fibers, cordage, or food, and still another large series of inquiries respecting the native grasses of different parts of the country and their respective worth for cultivation by the farmer and stock-raiser.

During the last four or five years there have been no botanical col

lectors on the government surveys, and consequently our most important means of acquiring knowledge of the vegetation of the Western Territories has been cut off. As has been stated, in this department full and complete information should be obtainable respecting the vegetable productions of all parts of our country. As explorations are pushed forward into remote sections, and new portions of our territory are brought under the influence of civilization and cultivation, new plants are discovered, and this division should have the means of keeping fully up with the progress of discovery, if not of itself extending these discoveries.

There are certain portions of our country, notably Oregon and Washington Territories, regarding the vegetation of which this division is very deficient as to information and specimens, and means are very much needed to place a good botanical collector in the field in these regions in order to supply these defects. We have mentioned the distribution of wood and botanical specimens which have been made by this division. There is a large field in this direction in which this division could greatly facilitate the advancement of intelligent agriculture. The young men who are now being educated in our Agricultural Colleges should have some knowledge of the prominent vegetable productions of the different parts of the world, and this knowledge can be best and most easily obtained by inspection and study of the objects themselves as they are presented in the museum and herbarium, and this department should have means at command to aid these institutions in this higher agricultural education. Very few young men in our northern colleges are acquainted with the cotton-plant, rice, or sugar-cane, even as they should be represented in museum specimens.

This department should be made a center of diffusion for these and other objects of agricultural or economic interest.

It is not necessary to go into details respecting our immense forest wealth, in its variety of 400 species of forest trees, nor to a consideration of the wants of a system of forest conservation, but we may say that this subject properly comes within the domain of this department, and that both scientific and practical talent should be employed in its management.

A very creditable beginning has been made in our grounds toward an arboretum, in which should be presented in a living state specimens of all the trees and shrubs of this country which can be grown in this climate. But the enlargement of this arboretum has been suspended for several years on account of a want of means to provide the very small necessary outlay. The wants and interests of the arboretum could be greatly promoted if this division could keep in the field one or more intelligent and capable botanical collectors, who would be able to obtain and send forward specimens of trees, shrubs, seeds, and fruits, so that here at the national capital there might be a full representation of the vegetable productions of our country.

MICROSCOPIST.

In addition to answering the numerous correspondents, both in this country and in Europe, the microscopist has during the past year made a number of original investigations in relation to the best methods of destroying insects and cryptogamic plants which prey on vegetation.

He has also made microscopic examinations for the different divisions of the department. An illustrated paper on the subject of edible mushrooms found growing in great abundance in the United States has been prepared, and will be published the coming year if funds for that purpose can be obtained. A number of microscopic specimens of morbid tissues for photographic illustrations accompanying the report on the diseases of domesticated animals were also prepared by the microscopist.

He has also made investigations relating to the fungus of cotton bolls, measurements of starch granules of sago, causes relating to sweet-potato rot, yellows of the peach, of the fungus known as *Rœstelia lacerata*, found growing on the leaves of the Russian apple-trees in the department grounds, &c.

SEED DISTRIBUTION.

Resolutions of granges and other agricultural organizations, letters from all parts of the country, favorable comments of newspaper editors, and last, but not least, the hearty indorsement of very many members of Congress to whom seed distribution had become an onerous burden, leaving them little time to give to their duties as legislators, and proving an endless source of annoyance and loss of popularity, indorse the action of the department in the matter of distribution of seeds according to the law, which directs the Commissioner of Agriculture to distribute seeds to agriculturists.

Through the four thousand regular correspondents and through information obtained from other citizens of the different counties, as well as from the prize lists and reports of county and State fairs, lists of the best farmers, numbering at the present time from ten to twenty in each county, regardless of political faith or anything else but their standing as farmers, have been obtained and entered on our books, and to some of these individuals, as well as to the agricultural societies in those counties, new and valuable seeds adapted to the localities are sent for experimental purposes.

While the limited amount appropriated for the purchase and distribution of seeds will not suffice for distribution to all the farmers on our books during any one year, yet something new will be sent to each county in the United States, and with diligence on the part of the recipient to cultivate and save seed and distribute among neighbors, any new or improved variety of grain or roots can soon be spread over any given county. The advantages arising from the introduction of improved varieties of seed are better understood by considering the effect in the increased production per acre. The area cultivated in wheat in

the United States aggregates in round numbers thirty-five million acres An increase of one bushel per acre would give an addition of thirty-five million bushels of wheat to the crop. This is equivalent to $35,000,000. Taking the past six years as a basis of calculations, the increased production per acre averages 1.2 bushels per acre for the last two years, being equivalent to a gain of $54,220,929 per annum in that time. The number of acres annually in oats in the United States during the past six years averages 11,987,626 acres. The increased production per acre by the introduction of the "Excelsior White Schoenen" oats some years since was some 2.5 bushels per acre, and a like increase is reported from the distribution of the "Board of Trade" oats in the northern and the "Rust Proof" in the southern part of the country during the last two years. At the same time the acreage was augmented one and a half million acres. But the average increased yield fairly attributable in like period to improved varities of seed would amount to forty million bushels, worth $15,000,000. Such substantial advantages speak so eloquently in behalf of proper seed distribution that further remarks would seem superfluous.

The following tabular statement exhibits the quantity of seeds put up and distributed to each State during the past year, except the miscellaneous column, in which it was found impracticable to designate the State. It is proper to say, however, that the system of keeping the seed accounts has been so changed as to show hereafter the destination of all the seeds distributed. It will be seen that a marked improvement has been made over former years, the number of packages having been increased by nearly half a million over that of the preceding year.

Tabular statement showing the quantity and kind of seeds issued from the Seed Division, Department of Agriculture, under the general appropriation act, from July 1, 1878, to June 30, 1879, inclusive.

Kinds of seeds sent.	Varieties.	Packages.	By request of Senators and members.	Agricultural societies.	Statistical correspondents.	Granges.	Special farmers.	Miscellaneous applicants.	Total amounts.
Items.			*Papers.*	*Papers.*	*Papers.*	*Papers.*	*Papers.*	*Papers.*	
Vegetable-seed	[illegible]	Packages	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Flower-seed	[illegible]	..do	[illegible]	....	[illegible]	....	....	[illegible]	[illegible]
Tobacco-seed	5	...do	19,358	....	....	....	11,918	5,397	36,673
Opium poppy	1	...do	31	....	....	....	....	136	167
Tree seed	31	...do	460	50	....	....	....	13,450	13,960
Herbs	19	...do	678	....	....	....	....	351	1,029
Borage	1	...do	26	....	....	....	....	9	35
Field seeds.									
Wheat	11	Quarts	5,853	5,792	13,324	....	25,246	10,258	60,473
Oats	5	...do	3,085	....	5,872	60	14,120	8,494	31,631
Barley	2	...do	1,475	96	428	1,424	....	1,276	4,690
Rye	1	...do	258	....	....	....	....	403	661
Buckwheat	1	...do	47	....	....	....	....	505	552
Field corn	1	...do	660	....	....	....	....	1,401	2,061
Potatoes	3	...do	1,437	720	3,416	488	4,244	2,693	12,998
Artichoke	2	...do	1,197	1,022	1,623	3,259	3,821	704	11,626
Sugar-beet	2	...do	76	....	....	....	314	427	817
Sorghum	1	...do	2,124	....	....	30	....	8,656	10,810
Grass-seed	3	...do	729	....	....	20	....	1,293	2,011
Clover-seed	1	...do	105	....	....	....	....	1,016	1,121

Tabular statement showing the quantity and kind of seed issued, &c.—Continued.

Kinds of seeds sent.	Varieties.	Packages.	By request of Senators and members.	Agricultural societies.	Statistical correspondents.	Granges.	Special farmers.	Miscellaneous applicants.	Total amounts.
Field seeds—Continued.			*Papers.*	*Papers.*	*Papers.*	*Papers.*	*Papers.*	*Papers.*	
Millet	2	Quarts	253					1,155	1,408
Rice	2	...do	119		2,288		1,086	486	3,979
Chufa	1	...do	212		1,978			358	2,548
Vetches	1	...do	6					6	12
Doura	1	...do	7					33	40
Tea-seed	1	...do	63				299	596	958
Broom-corn	1	...do	46		762			158	966
Coffee-seed	1	...do						104	104
Beggar's Lice	1	...do						2	2
Comfrey	1	Roots	20					83	103
Mushroom	1	Baskets	84					21	105
Textiles.									
Cotton	1	Quarts	110		1,372			713	2,195
Hemp	1	...do	15		162			18	195
Flax	1	...do						31	31
Ramie	1	Papers	2					93	95
Total			414,550	34,940	146,530	409,280	302,408	238,030	1,545,739

VETERINARY DIVISION—DISEASES OF DOMESTICATED ANIMALS.

Investigation of the diseases of domesticated animals instituted and conducted under the direction of the department has not been entirely confined to diseases of a purely infectious and contagious character, but embraced others of a well-known malignant and fatal nature. While the facts and information elicited are of the most interesting and important character, much yet remains to be positively determined before the work can be regarded as complete. The most valuable point thus far settled is that the disease so long known throughout the entire length and breadth of the country as "hog cholera" is a disease accompanied by few choleraic symptoms, is a purely infectious and contagious malady, and is communicated from one animal to another as all such diseases are, either by inoculation or by contact. This being the case, notwithstanding no remedies have as yet been discovered, the annual losses resulting from the malady among this class of animals will be greatly lessened by the measures taken by farmers and stock-raisers to prevent the communication of the disease from affected to healthy herds. Indeed, the good results of this investigation have already been felt in a marked degree, as the correspondents of the department report a great diminution of the disease during the past summer as compared with previous years.

In most cases this is attributable to better care of the animals, and to such precautionary and preventive measures as have been advised by those who have had charge of this investigation. In no respect has the fatal and destructive character of the disease changed, but it has been less widespread and general than in former years. It is confidently hoped that the experiments now being conducted under the direction of the department, and which are in charge of able veterinary surgeons,

will result in the discovery of either a remedy for this terribly devastating disease, or establish such measures of a sanitary and preventive character as will confine it to very limited localities. The disease has proved more destructive than any malady heretofore known to this or to any other class of domesticated animals in this or any other country. It has prevailed in the United States for nearly a quarter of a century, and while, perhaps, it has not increased in fatality, the losses occasioned through its instrumentality have increased in a like ratio with the increased number of animals produced, until the aggregate now annually reaches many millions of dollars. Careful returns from the correspondents of the department show these losses to be at present from $15,000,000 to $20,000,000 annually. It is, therefore, not unusual to receive intelligence from some of the large hog-growing localities in the West that the losses in single counties will reach the large sum of from $50,000 to $80,000, and in some instances as high as $150,000 in one season through the devastating operations of this disease. Neither is it a rare occurrence to be informed of the loss of an entire herd of thrifty and apparently healthy hogs within thirty days after the malady has made its appearance among them. The returns of the Statistical Division of this department show the number of hogs produced last year at upward of 32,000,000 head. This number is greatly in excess of any other class of meat-producing animals reared in this country, and shows the great necessity for the discovery of measures looking to their protection from disease. Millions of dollars are involved in this trade, but it is not alone the heavy losses annually sustained by our farmers that should claim our attention in a consideration of the subject. The fact of the existence of a terribly destructive disease among the swine of this country has already reached many European markets, and our salt and smoked meats have been prohibited entry and sale at ports where the business has heretofore been remunerative. While it has not been shown that the disease known as swine-plague can be communicated to man, at least in a fatal type, yet no diseased animal is fit for food, and it is a notorious fact that many entire herds of swine are slaughtered as soon as the disease is discovered to have made its appearance among them, and their meat placed upon the market for sale and ultimate consumption.

Equally alarming, and, unless effectual measures are at once adopted to stay its further progress, equally disastrous to the material interests of the country must inevitably prove the disease known as pleuro-pneumonia among cattle. In the early history of my management of the affairs of this department I called the attention both of the public and of Congress to the fact of the existence of this dreaded and destructive contagious disease in several of the Eastern seaboard States, and expressed the fear that it might be speedily transported to the great cattle ranges of the West, where, when once located, it would be found impossible to eradicate it. The agitation of the subject was continued until

several of the States where the disease was found prevailing inaugurated measures for its suppression. Their efforts were but partially successful, the failure being attributable alike to the insufficiency of the appropriation made for the purpose and a proper concert of action among the States immediately interested. Upon investigation, the disease was found prevailing, principally among dairy cattle, in the States of Connecticut, Eastern New York, New Jersey, Pennsylvania, Delaware, Maryland, the District of Columbia, and Virginia.

In New York City and vicinity the disease was found to prevail to a most alarming extent, and the legislature of that State at once adopted measures providing for its speedy suppression. A corps of able veterinary surgeons were employed, who commenced their work with an energy that gave promise of a speedy suppression of the disease by the safest and only effectual method, *i. e.*, by the condemnation and immediate slaughter of all animals suffering with or infected by the malady. A large number of animals were condemned and slaughtered, but it was soon found that the appropriation made for this purpose was insufficient, and the work had eventually to be suspended for the want of means to carry it forward.

This was much to be regretted, for, however carefully precautionary measures may be observed, until a further appropriation can be made it will be found almost impossible to confine the disease to the limits it occupied when the work was thus summarily suspended.

Partial efforts for the suppression of the malady were also made by the States of New Jersey and Pennsylvania, and possibly one or two more of the infected States, but these efforts were not prosecuted with that energy and determination that characterized the work inaugurated by the authorities of the State of New York. Where the work of suppressing diseases of this character is undertaken by the States separately and individually many difficulties will be encountered, and some of them will be found almost impossible to surmount or overcome. Unless there is perfect concert of action and entire harmony of purpose on the part of all the States interested, but little good can or will be accomplished in the end. The authorities of New York, by wise and energetic efforts and the expenditure of large sums of money, may extirpate the disease within its own borders, but so long as it is allowed to exist in contiguous States it is liable any day to be carried again over the borders and into the herds from which it has just been eradicated.

GARDEN AND GROUNDS.

The chief object of the garden of this department is the propagation and development of plants that are likely to prove of general utility.

The area devoted to this purpose is entirely inadequate.

The department cannot do justice to itself or the country until experimental grounds here and in different sections of the country are placed

at its disposal. There are many semi-tropical productions of great commercial value, which can now only be treated in a limited way as tender hot-house plants, which they practically are in this latitude, and are consequently placed under conditions for propagation, which not only limit their quantity but depreciate their value.

There is pressing necessity for increased facilities for cultural experiment to test the practicable cultivation of such plants as the olive, tamarind, banana, pineapple, coffee, tea, theobroma or chocolate, orange, especially the bergamot or otto yielding plants, ginger, pepper, cinchona, and many others of commercial value. There are sections of the country whose climate will admit of the propagation of these plants in the open air, in which the cost of production may be put to a practical test. In the absence of means to provide these facilities, the department finds it impossible to fully discharge the primary duties with which it is charged in the act establishing it, viz., "to test by cultivation the value of such seeds and plants as may require such tests, to propagate such as may be worthy of propagation, and to distribute them among agriculturists."

Time and again it has been asserted that coffee was found growing wild in Florida, but an examination of the bush and berries sent the botanist of the department has resulted thus far in disproving the assertion.

I have, however, within the past few days been informed by Ex-Governor Gleason that he himself had seen coffee growing wild on Cape Biscayne, that he had picked the berries, and that a grant of land had been made to a company to induce them to plant coffee on the peninsula.

The reason does not appear why this enterprise was abandoned, but abandoned it was long years since, and the record and memory of the attempt have been almost forgotten.

Accurate botanic information will now soon be obtained, and if coffee is growing on Cape Biscayne the fact will be established.

COFFEE.

Whether there is any part of the United States in which coffee can be cultivated has been a question discussed for years and until recently undecided. A practical solution of this question has at last been reached by Mrs. Julia Atzeroth, of Braiden Town, Manatee County, Florida, who has sent to the department a branch of coffee grown in the open air in her garden. In her letter accompanying the coffee, she says:

Gen. W. G. Le Duc,
Commissioner, Washington, D. C.:

Dear Sir: Yours of the 20th of last month arrived safe, and I can assure you I felt greatly honored to find that you appreciate my experiment in growing coffee, and that mine should be the only coffee in the United States. I feel sure it can be successfully grown further south where frost never comes, and there is an abundance of

land and soil suited to its growth. My trees are now attracting considerable attention. Many persons come to see them and ask for seed.

I have given some seed and I will try to encourage its cultivation, to improve the country thereby. That is why I tried it, and now I feel satisfied it will be a success, if fairly tried. I came to this State some thirty years ago, and am one of the first settlers in Manatee. I would like to see you and tell you my experience in Florida. I would not exchange my home for any other State I know of. Florida needs nothing but energy and industry to make its people independent.

The department has supplied Mrs. Atzeroth with a number of young trees with which to enlarge her experiment, and also furnish other persons in the same locality and further south with plants which should, if carefully planted and successfully cultivated, bear coffee within five years.

It is something to know that a lodgment has been effected on the coast of Florida, and though four trees, so far, are known to have been successfully grown and fruited, yet whether the coffee will ripen thoroughly and prove as profitable here as it has in other countries is yet to be determined.

TEA.

The efforts of the department to introduce the culture and manufacture of tea have been steadily continued and with a fair prospect of ultimate success. Of the 69,000 plants distributed last year, the reports indicate a loss of about one-half, owing to carelessness and failure to protect them from the hot summer sun; but the applications of the farmers are numerous and the distributions of the department during the fall of 1879 and spring of 1880 will be continued.

The kaki, Spanish chestnuts, English walnuts, olives, camphor-trees, and other plants and vines distributed the past year are uniformly reported upon as thriving and doing well.

There have been distributed from the garden during the past year, 28,000 strawberry-plants, 9,748 grape-vines, 69,154 tea-plants, 13,921 plants of orange, olive, fig, and semi-tropical fruits and plants of various kinds, 5,000 plants of Japan persimmons, 70,000 scions of Russian apples.

A letter from an intelligent correspondent, Mr. Weaver, of Bogota, South America, whose opportunities of observation have been ample, and whose opinions upon the cultivation of coffee and cinchona are entitled to considerate attention, is produced in the appendix for the encouragement of those who are inclined to help the department to make this interesting experiment.

The clerks and working force of the department, under the able direction of the chief clerk, have accomplished an unusual amount of valuable labor; but if the force of the department were doubled every year for the next five years it could be employed with great profit to the country.

The following table exhibits in a condensed form the appropriations

made by Congress for this department, the disbursements and unexpended balance for the fiscal year ending June 30, 1879:

	Amount appropriated.	Amount disbursed.	Amount unexpended.
Salaries	$66,900	$66,900 00	
Collecting statistics	10,000	10,000 00	
Purchase and distribution of seeds	75,000	75,000 00	
Experimental garden	7,000	7,000 00	
Museum and herbarium	1,000	1,000 00	
Furniture, cases, and repairs	4,000	4,000 00	
Library	1,000	1,000 00	
Laboratory	1,500	1,500 00	
Contingent expenses	8,000	8,000 00	
Postage	4,000	4,000 00	
Improvement of grounds	6,500	6,500 00	
Printing and binding	11,000	6,073 55	4,926 45
Investigating the habits of insects, &c	10,000	10,000 00	
Investigating the diseases of swine, &c	10,000	10,000 00	
Erection of stable	1,500	1,500 00	

For the purpose of comparison, the amounts appropriated for the various departments of the general government for the fiscal year ending June 30, 1879, is herewith appended:

Object of appropriation.	Amount appropriated.
Congress	$6,286,472 72
Executive proper	101,064 00
State Department	7,134,325 64
Treasury Department	167,122,213 75
War Department	68,263,792 48
Navy Department	20,684,492 83
Interior Department	38,245,551 74
Post-Office Department	7,295,389 98
Department of Justice	3,918,913 94
Department of Agriculture	204,900 00
Total	$319,257,117 08

IMMEDIATE NECESSITIES OF THE DEPARTMENT.

The immediate necessities of this department, beyond the appropriations usually made for its ordinary working, may be stated:

1. A laboratory of proper size and fully equipped, to cost not less than $300,000, with a sufficient appropriation to meet the expenses of the additional force that will be necessary to carry forward investigations on a larger scale than the present laboratory and appliances will permit; and the further sum of $5,000, made available immediately, to pay for labor and material necessary in the pressing work of this division.

2. An experimental farm of 1,000 acres of ground, in the neighborhood of this city, and five experimental stations in different sections of the country, viz., one in California, one in the interior of the continent (to be devoted to the introduction and preservation of the best breeds of domesticated animals and to the domestication of some of the native wild animals of the country, among them the Buffalo), one in Texas, one

in Florida, and one in New York above the latitude of Albany. To inaugurate these farms a large sum will not be necessary, and after the first year the expense will be more than paid by the results of the cultivation at each station.

3. An increased appropriation for the gardens and grounds of the department, which embraces experimental cultivation and propagation of trees, plants, &c., for distribution. This appropriation should be increased to at least $15,000.

4. An increased appropriation of $5,000 for obtaining new material, employing labor, and otherwise extending the benefits arising from the museum and botanical divisions of this department.

5. A renewal of the appropriation of $10,000 for the examination of the diseases of domesticated animals.

6. A renewal of the appropriation for continuing the investigation of the history and habits of insects injurious to agriculture. Ten thousand dollars at least should be annually expended in that direction by the department.

7. An additional appropriation of $6,000 to continue the work on forestry.

Permission and direction to occupy and plant on the government land on the Coteau d'Prairie, a forest conforming to the width of the coteau and extending the entire length of the elevated land from the northern end near Bigstone Lake toward the Iowa line.

A re-establishment of the forest which once grew on this elevated land would increase the value of the government land far beyond the cost of planting, and can and would also afford an opportunity of ascertaining the meteorological and other beneficial changes that would probably take place in consequence of the establishment of so large a body of timber crossing the path of the severe storms that sometimes sweep with terrible energy and devastation across those naked plains. The lands are owned by the government, and they can be reserved from sale for this purpose. The experiment need not be an expensive one, nor can there be any doubt about the favorable result even as a profitable investment.

The same thing should be done in the middle plains, commencing at the South Park and running southeast. With these two experimental forests many questions now discussed could be settled, and much knowledge of a most interesting and valuable character could be furnished to the people.

A tract of country at the foot-hills, on the east and west side of the Rocky Mountains, usually considered an arid desert, and estimated to be equal to nearly one-fifth of the productive area of the United States, when irrigated, has been found to be astonishingly productive, especially for all the cereals that are commonly used for the support of human life.

The inadequacy of the streams which run from the mountains into these plains and irrigate the country, the excess of the population of

the mines which demands more food than can be raised upon the lands that are irrigated from these streams, and the general welfare of that section requires that the government should take some active interest in ascertaining whether by artesian wells in different locations large areas of the country may not be profitably watered and made productive. The experiments recently made by the French engineers in the great deserts of Africa are well worthy of imitation in this country wherever it would seem practicable. As preliminary to more extended operations, an appropriation of $50,000 to be immediately available should be made to examine with the drill the practicability of irrigation from artesian wells.

A building for the exhibition of working models of agricultural machinery is a want long felt, and which would be of the highest interest and instruction to all persons visiting Washington from all parts of the United States and from foreign countries. Such a collection could be made, if the building was furnished by the government, with very little expense. Nearly every manufacturer of agricultural machinery would be glad to contribute a specimen of the tools or implements manufactured. This building should occupy the southwest corner of the grounds, and should be of sufficient extent to provide for some years in the future, and should form part of the permanent building which the department will necessarily require.

In every county in the United States in which agricultural industries are pursued, this department has or aims to have a principal correspondent and four assistants. These should all be furnished with sets of instruments for taking the temperature of the air, the soil, the pressure of the atmosphere, and the degree of moisture present in the atmosphere. As the work of these correspondents is given gratuitously, the government ought to supply the instruments necessary for making the observations, and an appropriation for this purpose, and for furnishing record-books and other stationery, should be made.

Very respectfully, your obedient servant,

WM. G. LE DUC,
Commissioner of Agriculture.

The PRESIDENT.

APPENDIX.

To the Hon. WM. G. LEDUC,

Commissioner of Agriculture, Washington, D. C., U. S. A.:

SIR: I have noticed a circular issued by the department seeking information in regard to coffee. As I have frequently passed through the cold-country coffee region in this neighborhood, and have made it a point to inform myself as to the particulars of the culture and habits of the plant, I take the liberty of writing you as follows:

It is true that the coffee does not require a very hot climate. In fact, that which is raised in the colder regions is most highly esteemed and brings the highest price in the home and European markets.

Its upward range is limited by the frost-line, as is that of the orange, plantain, and bamboo. In a table compiled from Boussingault and Humboldt, the coffee appears as the hardiest of these, enduring a temperature one degree colder than the orange, three colder than the plantain, and five colder than the bamboo. Local authorities assure me this is a mistake as regards the orange, which is more hardy than the coffee. An English writer fixes on the bamboo as a test, saying that wherever it grows the climate is suitable for coffee. There seems to be no doubt that the coffee will endure more cold than the bamboo, so that the latter fails to serve as an indication of the *northern* limit of the coffee. And for this reason, both the coffee and the orange will grow at a height so cold as to prevent their having fruit. But as the Southern summer has a genuine hot-country temperature, the coffee would bear, as the orange does, in the season, if it could be carried through the winter.

This is the crucial point. Even in the plantations below the frost-line the coffee suffers at times from an extraordinary visitation of frost, or from the cold produced by a hail-storm, and it is generally admitted that a frost will kill it. On the other hand, it is said to grow, in peculiar circumstances, above the frost-line. Here in Bogota, for instance (temperature 60° F.), it will grow, without bearing, in the open air about the houses, but it will not live out on the plain where there are frosts so heavy as to often kill the potato. This is merely an illustration of the fact, well understood in the North, that a frost, like a dew-fall, and unlike a freeze, can be guarded against by a slight covering—the shade of a tree or building often serving to protect the vegetation in its vicinity while that more exposed is blighted. Now it is deemed essential that the coffee-plant should be shaded. The usual plan is to plant the coffee and the plantain together, so that the latter by its rapid growth may furnish shade before the coffee needs it. Some prefer to plant, also, certain fruit-trees to take the place of the plantain at a later date. The excessive heat of the summer in the Gulf States would certainly call for a liberal shading of the plantations. The question then arises as to whether the shade provided for summer would serve to protect the plants from frost in the winter. As I have no personal knowledge of the severity of the winter or of the character and habits of the trees available for this purpose, I cannot form even an opinion as to the probability of the success of the experiment. The question would still present itself whether it might not be feasible to protect the plants by keeping the ground wet, which is said to be sufficient to save the potatoes here, or by coverings of straw, or by smoldering fires raising clouds of smoke on exceptionally cold nights. I believe that the large profits of the coffee culture would warrant even these measures if they were found to serve the purpose.

The best crops that I have seen have been on a rich black loam, too rocky to be worked with the plow, and on the slopes of ravines. It is said that the plant dies out in a few years on clay soil. But the Liberian plant is said to flourish on such soil. It belongs, however, to the very hottest of climates. I attribute the better condition of the plants on sloping ground to the fact of their being more shaded. If the shedding of water more readily has anything to do with it, that could be effected on level ground by proper drainage. It is generally held that the coffee will not flourish on wet ground, though the best plants I ever saw were within a few feet of an unfailing stream.

The fact is that agriculture in tropical countries is done in such a slovenly manner; so few experiments are tried, and those few so carelessly; there is such a lack of accurate observation and comparison of notes, as well as of enterprise and sound judgment, that it is difficult to arrive at broad and accurate generalizations on many of

these subjects. As a rule, each man attributes to the nature of the plant effects which arise from the accidents of his location or treatment.

As with all small fruits, the perfection of the coffee berry depends on a good supply of moisture. In the tropics the principal crops follow immediately after the close of the rainy seasons, and if the rains fail the crops are light, as the berries dry up and fall off without ripening. The heavy summer rains in the Southern States would probably come just at the right time. But I should not advise any one to put in coffee on a piece of ground that could not be irrigated, though it is often done.

Practice varies in regard to the number of plants to the acre. After looking over a plantation, noting the plants in best condition, and making measurements, I determined, to my own satisfaction, that the best way, in a cold country, at least, is to plant in rows four yards apart and two yards apart in the row. The branches interlock in the row (which some regard as necessary), and the distance between the rows allows of moving about for cultivating and gathering. By trimming, the foliage can be made as open or as crowded as may be deemed best, while the wider spaces between the rows allow of the extension of the branches in that direction if they should be crowded in the other. This gives about 600 plants to the acre.

The yield is estimated sometimes as low as two pounds to the plant. But the same cultivator who gives me this figure says he is convinced that the increase of the yield indefinitely is only a question of improved cultivation. A more usual estimate is three pounds. A Scotchman in the neighborhood, who has brought more intelligence and care to the examination of the matter than any other cultivator here, claims to have plants under special cultivation that yield ten pounds each. This is about the figure claimed for the Liberian plant. No one could foretell what would be the result of transferring the plant to a country where it would have but one bearing season, instead of two, as here; but it is natural to suppose that it would exert itself with exceptional vigor in that one season. In all probability the more careful and judicious treatment that it would there receive would produce results even beyond those commonly attained in this country.

It is claimed that the Liberian plant, and perhaps some others in the hot country, are in full bearing at three years of age. This is not true of the colder country, where they just begin to bear at three years, and attain their maturity at from five to seven years. Here is the chief expense of getting up a plantation. The first investment has to lie unproductive, and the weeds have to be fought unceasingly through these years. When once the plants obtain their growth their shade keeps the weeds down almost without further attention.

It is usual here to estimate the expense roughly as half the value of the coffee. That raised in this neighborhood was sold last year in Bogota or Honda at about 20 cents per pound, and the planters counted that half clear: that is, they allowed 10 cents a pound for expenses. The Scotchman above mentioned has satisfied himself that the cost of production is but 5 cents a pound.

I conclude, then, that coffee can be raised successfully over a large part of California and in the Lower Colorado and Rio Grande Valleys, where irrigation is practicable; that it is exceedingly doubtful whether it could be raised in the Gulf States; that there may be a possibility of this being accomplished through careful experiment and persistent effort, having a view to the discovery of a method of cultivation adapted to the climate or to the production of a hardier variety, as was done in Russia in the case of wheat; that the importance of the matter, viewed in relation not only to the aggregate cost of importations into the United States, but considered also as one of the most profitable branches of agriculture, which it certainly is, would justify almost any outlay necessary to test the question systematically and thoroughly.

There is another matter to which I beg leave to call the attention of the department, and which is to my mind less doubtful and far more important. I refer to the

CULTIVATION OF THE CINCHONA.

It is well known that the plantations in India have surpassed the most sanguine expectations of their founders. Some of the English papers have reported the annual yield as reaching a value of $8,000 per acre. I consider this quite possible, in view of the fact, which can be verified by reference to the trade reports, that the mossed barks bring as much as eight shillings a pound in the London market.

Now, I have observed that *the cinchona region begins just about where the coffee climate ends.* In this country, as in all South America, the cinchona has been exterminated in all regions readily accessible, so that it is a matter of the greatest difficulty to obtain a sight of a growing tree. But in passing repeatedly through forests in which it had once flourished I have been impressed with the conviction that similar conditions could be found in many parts of the Southern and Pacific States.

The cinchona seeks the heights of the mountains where it is subject to frequent visitations of frost. I have said that at the altitude of this city (8,650 feet, temperature 60° F.) there are heavy frosts; yet the cinchona *cordifolia* of this region grows nearly

a thousand feet above this elevation. According to Cross, the cinchona region has a temperature varying from 60° to 35° or 35°. This is all above the frost line, and is subject to continued hail-storms in the rainy season, and even to freezing in the upper portions. One of the most valuable and most easily cultivated of all the varieties, *C. pitayensis*, was found by Dr. Weddel in a temperature varying from 60° to 30°. *C. succiruba*, the prince of cinchonas, grows in a warmer climate, sometimes reaching to 70°.

It is evident from the above data that the cinchona region has a climate covering at least forty degrees of extreme variation, and that single varieties endure a variation of about thirty. This is greater than the maximum variation at certain points on the Pacific coast. It may be possible that elevated situations could be found near the coast in which these very grades of temperature are reproduced. It is true that on the sea-coast the thermometer rises higher even than 70°, but it is yet to be shown whether the cinchona cannot endure a northern summer of a few months' duration.

That calculations of this nature are only approximate is shown by the fact that the cinchona region, as described, includes the entire range of the oak and nearly that of the walnut. If one were to form a judgment as to the range of these two trees, based on observations here, he would have to conclude that they would flourish only in a temperature varying from fifty to seventy-five degrees, as that would take in their upper and lower lines on the Andes. To tell one who knew these trees only as found here that they would survive a northern season of either summer or winter, would be to repeat the experience of those who tried to convince the King of Siam of the existence of ice. *It remains to be discovered whether the endurance of the cinchona may not equal or nearly equal that of the walnut, oak, willow, apple, peach, and wild cherry, all of which seek as low and some a lower range on the Andes.*

I am unable to learn that the cinchona is found as far south as the twentieth parallel of latitude. Its extension north must have been limited, as Humboldt suggests, by the lowness of the mountain range of the isthmus. But, whatever may be the cause of its limitation on the south, the English have shown that it may be extended on the north by artificial means. The plantations in the Punjaub are above the thirtieth parallel; that is to say, at the same latitude as the Gulf States, New Mexico, Arizona, and Southern California, It is true that the Himalaya Range protects the Punjaub, making it a true portion of the tropics. But as the plantations there are at some elevation above the sea-level, and as very nearly the natural conditions as to temperature do actually exist on the Pacific coast of the United States, there seems to be no antecedent improbability in the supposition that the culture may be extended further north.

The cinchona seems to seek a dry soil, but a climate affording plenty of rain in certain parts of the year. The coasts of Northern California and Oregon would fulfill the conditions as to moisture; the slopes of the mountains would probably furnish hilly ground, very similar to that occupied by the tree in its native habitat; while I believe that the temperature would admit of its cultivation even north of the mouth of the Columbia. It is also uncertain as to how far any undue dryness of the atmosphere may be overcome by irrigation. The surprising results already attained in the cultivation of the trees prepare us to expect further advances, and this may be one of them as naturally as anything else.

It is well known that the barks produced under cultivation are much superior to the natural bark, as the process of mossing the tree causes a remarkable development of the alkaloids in which their virtue consists. Also that the cultivated trees are not destroyed. A strip is taken off reaching the length of the trunk and one-third of its circumference. The wound is then dressed with straw matting and kept wet until the bark forms anew. The next year another strip is taken, and so on, indefinitely. I am told that the harvest begins when the tree is five years old, but am not in a position to verify the statement.

I have calculated roughly, according to the prices of land and labor here, that a plantation of a hundred acres might be put in at less than a thousand dollars an acre, covering all outlay—or say fifteen hundred dollars to cover interest and all contingencies. I do not see why it should cost more in the States, as labor, if dearer, is proportionally better. Accurate estimates could probably be obtained from the English growers.

To sum up the matter, I believe that, with a wise choice of sites and judicious treatment, together with a careful selection of the proper varieties, the cinchona could be cultivated in many parts of the Pacific coast and probably in New Mexico; that if irrigation can be made to supply the place of a naturally moist climate, the cultivation can be carried into a large part of the Colorado Valley and Texas, as well as into Northern Georgia and Alabama, and thence north along the southern slope of the Blue Ridge. I should not be surprised if the hardier varieties were found to grow even in Virginia and Colorado and in Arkansas, in favored situations on the southern slopes of the Ozark Mountains.

Thoroughly convinced, as I am, that it is possible to cultivate the cinchona in the

United States, I venture to call the attention of the department to the matter as being one of the most important that can claim attention. The fact stares us in the face that the American supply of bark is becoming rapidly exhausted. Whole districts are devastated every year, hundreds of thousands of trees being destroyed, root and branch, while scarcely any effort is made to replace them. Inferior and even false barks that were formerly entirely overlooked, now form the exclusive production of some districts, while few places in these countries now remain unvisited. The natural supply will soon be exhausted, and the East Indian plantations will then be the only source of supply for the commerce of the world. When that time comes, and it will come sooner than our people expect it, a general European or Asiatic war, or even a war of the United States with any foreign power, might completely cut off the supply of this drug, which is a real necessity in many parts of the country. Even such an appalling disaster as the destruction of the Indian plantations by the ravages of war is not without the range of possibility.

Not only that; even while the supply lasts it can never be too great. The blessings of this beneficent remedy should be placed and kept within the reach of the poorest in the land, and the government fulfills its highest mission when it provides by a wise foresight the means of holding in check the merciless destroyer that has driven a hundred armies from the field and fills with terror some of the fairest portions of the globe.

WILLIS WEAVER.

BOGOTA, *October* 18, 1879.

REPORT OF THE CHEMIST.

SIR: I have the honor to present the following report of work performed in the chemical division of the department since the 27th of May, 1879—the work accomplished previous to that period having been included in the annual report for 1878.

The following is a summary of the work done:

1. Analyses and assays of minerals and ores, including calcareous and phosphatic marls (152 in number).
2. Analyses of mineral, spring, and well waters (6 in number).
3. Analyses of soils (8 in number).
4. Analyses of super-phosphates and commercial fertilizers (20 in number).
5. Analysis of rock-salt from Iberia Parish, Louisiana.
6. Analyses of wines and liquors (13 in number).
7. Analysis of paint.
8. Analyses of butter and oleomargarine (5 in number).
9. Analyses of poisons (6 in number).
10. Analyses of sugar-beets (9 in number).
11. Complete proximate analyses of grains, including corn, rice, wheat, sorghum, and doura-corn (24 in number).
12. Complete proximate analyses of native grasses (52 in number).
13. Complete proximate analyses of stalks, bagasse, and leaves of sorghum and maize (9 in number).
14. Analyses for sucrose, glucose, and other solids in different varieties of sorghum, maize, pearl millet, sugar-cane, watermelon, &c. (232 in number).
15. Complete proximate analyses of medicinal and poisonous plants (7 in number).
16. Analyses of juices from sorghum, maize, and pearl millet (59 in number).
17. Complete proximate analyses of green corn and cobs (4 in number).
18. Complete proximate analyses of precipitates obtained in defecation of juices from sorghum (3 in number).
19. Experiments in making alcohol from sorghum and corn-stalk molasses (5 in number).
20. Analyses of baking-powders (2 in number).
21. Analyses of coffee-berries, artificially colored (12 in number).
22. Analyses of powders used in artificially coloring coffee (3 in number).
23. Estimation of tannin in sumac.
24. Analysis of ash of maize.
25. Analysis of sorghum sugar.
26. Analysis of lignite.
27. Proximate analyses of hay (5 samples).
28. Analysis of salts from evaporated lake water, Lake View, Oregon.
29. Proximate analysis of tuckahoe.
30. Effect of cooking upon cane-sugar.
31. Analysis of fresco-efflorescence.
32. Experiments in making sugar from four (4) varieties of sorghum, pearl millet, sweet corn, field corn-stalks, and watermelons (35 in all).

EXPERIMENTS IN THE PRODUCTION OF SUGAR FROM SORGHUMS AND MAIZE.

During the past season there have been made several series of investigations for the purpose of determining the development of sugar in the juices of several varieties of sorghum, maize, and of pearl millet.

These investigations appear to demonstrate that there exists little difference between the various kinds of sorghum as sugar-producing plants; and, what is quite a surprising result, each of them is, at a certain period of its development, nearly if not quite as rich in sugar as the very best of sugar-cane. It is a matter, also, of extreme practical importance that this maximum content of sugar is maintained for a long period, and affords sufficient time to work up a large crop. Another result of these investigations has been to satisfactorily explain the cause of repeated failure in the production of sugar during the past quarter of a century, and to give the assurance that in the future such failure need not attend this industry. For the purpose of making clear the above points, the results obtained in the laboratory and in out-of-door experiments are appended.

The varieties of sorghum grown and subjected to continuous investigation during the season were Early Amber, White Liberian, Chinese, and Honduras, and Pearl Millet. Besides the above there were made very many examinations of other specimens of sorghums and corn-stalks; all the results of which only confirmed the general principle above stated, viz., the practical equality and great value of every variety of this plant.

Of the following plates the first four represent varieties of sorghum grown during the past season on the grounds of the Department of Agriculture at Washington, and used in the experiments of the chemical division as detailed in this report. The drawings were made by a gentleman employed in the department. The designations given them are somewhat different from those current in some parts of the country, but are conformed to what are believed to be the most authoritative standards.

Plate I represents the Early Amber Sorghum, the favorite variety with planters in Minnesota and the Northwest. What is now called the Minnesota Early Amber cane is claimed as an improvement upon the Early Amber varieties grown formerly in differents parts of Minnesota, by Hon. Seth M. Kenny and Mr. C. F. Miller of that state. Acting on the theory that cane in a high latitude will degenerate if grown continuously from its own seed, these gentlemen selected the finest specimens of seed from their own crops and sent them to a southern latitude to be grown. The seed product of this southern growth was returned to Minnesota. By this alternation of seed, and by other intelligent processes of culture they have succeeded in establishing a new and permanent variety, which they claim to be more productive in weight of cane and to contain a higher per cent. of saccharine matter than any other grown in that State. This claim needs to be substantiated by more careful and extended observations before it can be said to be fully established.

Messrs. Kenny and Miller describe the Early Amber cane as presenting "the characteristics of both sorgo and imphee." By sorgo they mean the Chinese sorgo (Plate II), and by imphee, the White Liberian (Plate III), and its kindred African varieties. The early amber receives its name from its early ripening and from the bright amber color which characterizes its sirup when properly made.

The early amber cane on the department grounds did not grow quite

so tall as the white Liberian. Its seed-heads were of moderate fullness and of very dark color.

Plate II shows the Chinese Sorghum grown on the department grounds. Its height is about that of the Early Amber. Its seed-heads are fuller and more compact and somewhat resembles a head of sumac; hence the synonym "Sumac Cane." It is also known as "Chinese Cane."

Plate III represents the White Liberian sorghum grown on the department grounds. This variety is rather taller than the Early Amber. The stalk curves at the top leaving the head pendent; hence the synonym "Gooseneck." The seed-heads are shorter, more compact, and of lighter color than the Early Amber.

Plate IV shows the Honduras Sorghum grown on the department grounds. It grows about one-half taller than either of the above varieties. Its seed-top is reddish brown and spreading; hence the synonym "Sprangle Top." It is also called "Mastodon" and "Honey Cane."

In the following table are given the results of the analysis of each of the plants in the successive stages of development. It will be observed that the amount of glucose (or uncrystallizable sugar) diminishes, and the amount of sucrose (or true cane sugar) increases. It will also be observed that the plants differ widely in the date when the sucrose is at its maximum, but are alike in this, that this maximum is attained at about the same degree of development of the plant, viz., at full maturity, as indicated by the hard, dry seed, and the appearance of off-shoots from the upper joints of the stalk. It is also to be observed that the heavy frost of October 24, which was sufficient to produce one-half inch of ice, did not cause any marked diminution of sugar.

For purpose of comparison, analyses are also appended of three varieties of sugar-cane received from Louisiana, which arrived in excellent condition, and doubtless fairly represented the average character of this famous sugar-plant.

It will be understood that the results of these tables are to be taken as a whole, since it was practically impossible to secure in each case specimen stalks for examination in the laboratory, the development of which in every case corresponded to the date when the plant was cut, and, therefore, it doubtless happened that plants taken from the same row upon September 15, for example, were in reality no further developed than those selected a week earlier, but taken as a whole the several series of analyses are convincing as showing the rate and progress of development of saccharine matter in the plant.

By reference to the tables it will be seen that the analyses of the several sorghums under date of October 29 were made after they had been subjected to a very hard frost, sufficient to have formed ice one-half inch in thickness, and this cold weather continued for four days before this examination was made. As will be seen, there appears no diminution of sucrose in either of the stalks examined, and no increase of glucose as the result of this freezing and continued exposure to a low temperature. The examination of November 8 was made after a few days of warm weather had followed this cold spell, and the influence of this subsequent thaw is noticeable in the diminution of sucrose and the increase of glucose in each specimen examined.

From this it would appear that the effect of cold, even protracted, is not injurious to the quality of the canes, but that they should be speedily worked up after freezing and before they have again thawed out. This is a matter of such practical importance that some experiments should be made to learn whether the sirup prepared from the juice of

frozen cane differs from that prepared from cane not frozen, but in other respects of like quality.

The Early Amber, Chinese, Liberian, and Honduras Sorghums and the Pearl Millet examined, mentioned as having been grown upon the department grounds, were all planted the same day, May 15, 1879.

The relative weights of the different kinds of sorghum experimented upon are as follows:

	Pounds.
Early Amber, average of 40 stalks	1.73
White Liberian, average of 38 stalks	1.80
Chinese, average of 25 stalks	2.00
Honduras, average of 16 stalks	3.64

Since these were all grown side by side and upon land presumably of equal fertility, it will afford the data for calculating the relative amount of each variety to be grown per acre.

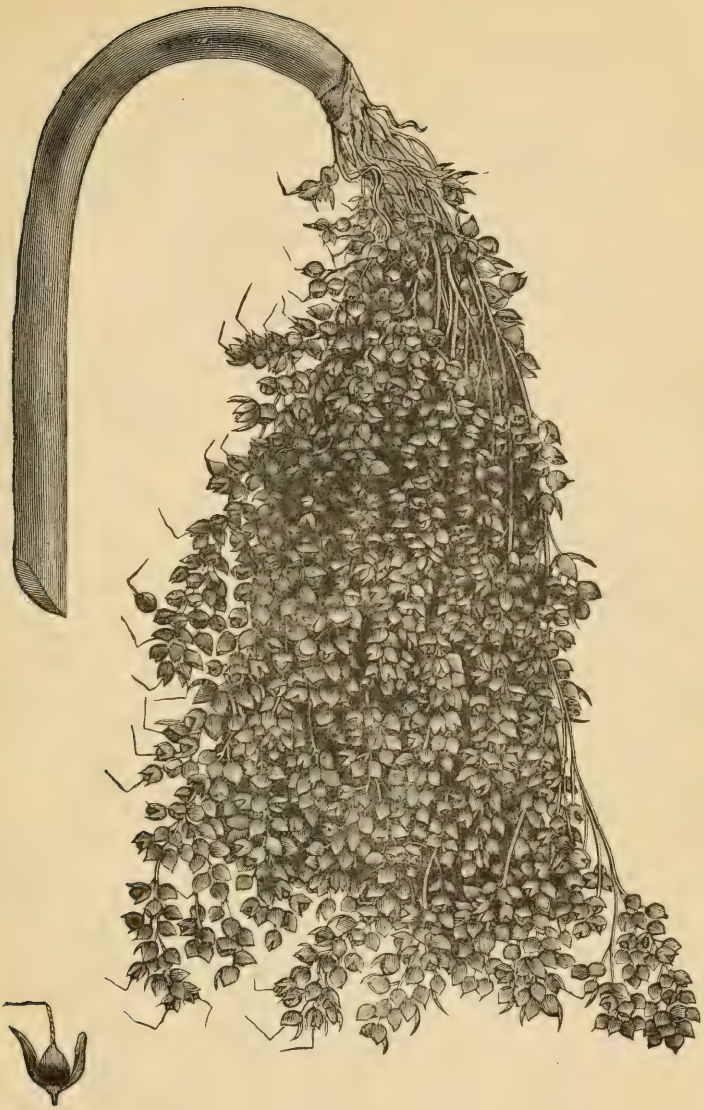
EARLY AMBER CANE.

[Grown upon the Department grounds during the season of 1879.]

CHINESE SORGO CANE.

Synonym: SUMAC CANE, CHINESE CANE.

[Grown upon the Department grounds during the season of 1879.]



WHITE LIBERIAN CANE.

Synonym: GOOSE NECK, White Imphee.

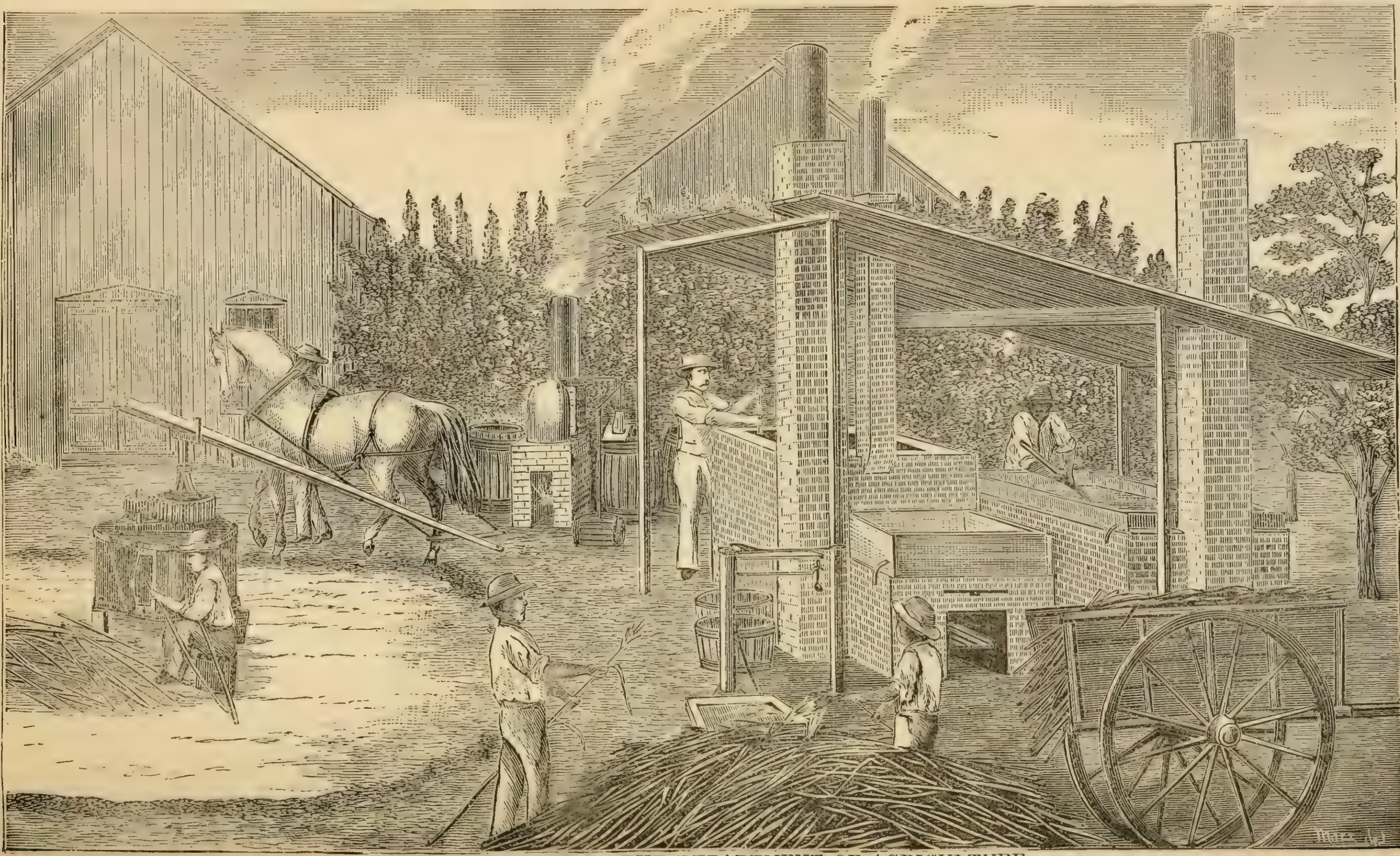
[Grown upon the Department grounds during the season of 1879.]

HONDURAS CANE.

Synonyms: MASTODON, SPRANGLE-TOP, HONEY CANE.

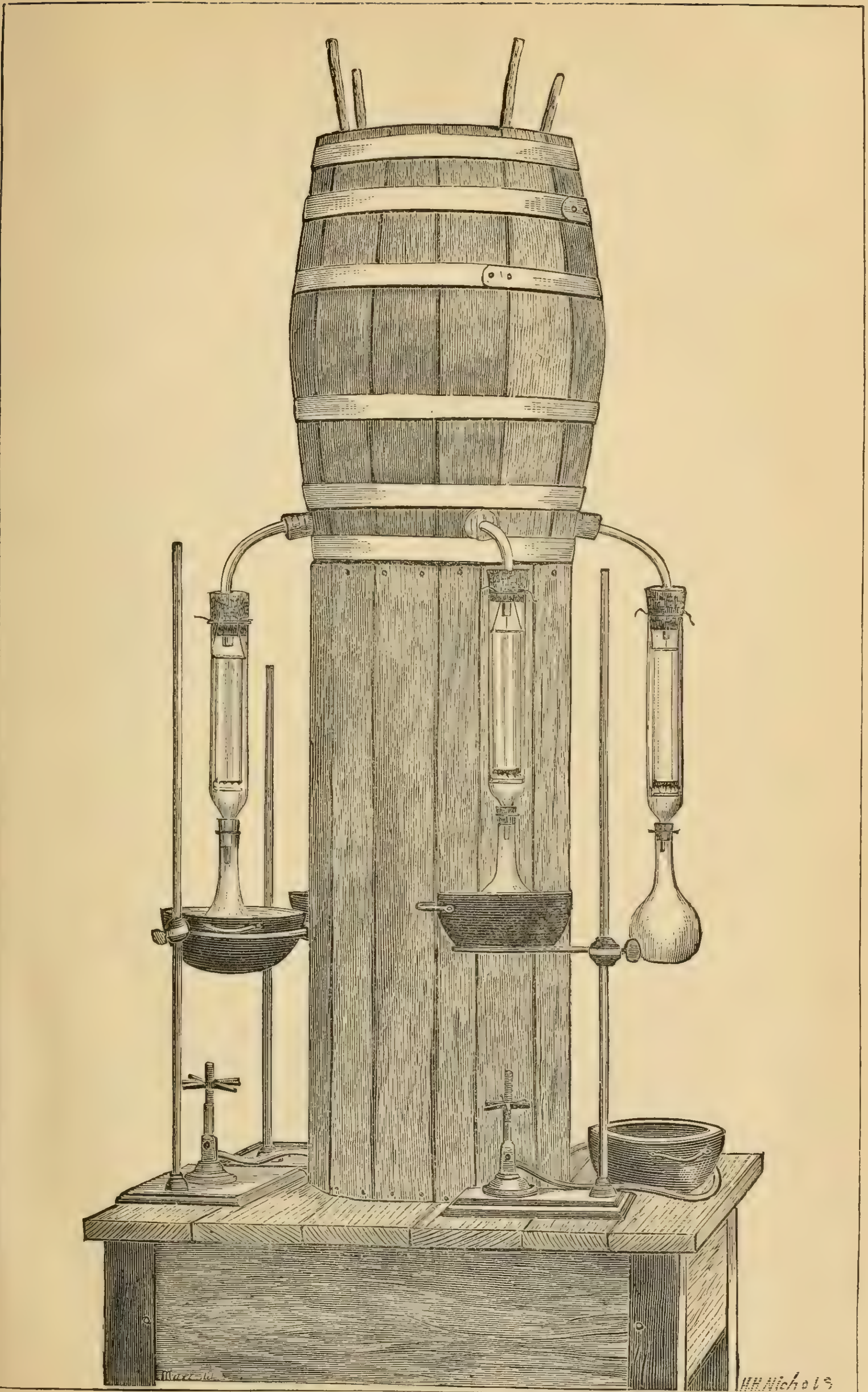
[Grown upon the Department grounds during the season of 1879.]

Plate V.



SUGAR MACHINERY OF THE DEPARTMENT OF AGRICULTURE.

[United States Sugar Mill. Experiments for two years on grounds of Department of Agriculture. Description in the Chemist's Report.]



APPARATUS FOR CONTINUOUS PERCOLATION.

EARLY AMBER.

Date.	Development.	Number of stalks used for analysis.	Height of entire stalk, in feet.	Height of top, in feet.	Height of butt, in feet.	Diameter of butt, in feet.	Weight of entire stalk, in pounds.	Weight of stripped stalk, in pounds.	Weight of top, in pounds.	Weight of butt, in pounds.	Per cent. of water in top.	Per cent. of water in butt.	Average per cent. of water in cane.	Weight of juice in top, in pounds.	Weight of juice in butt, in pounds.	Total weight of juice, in pounds.	Per cent. of juice in entire cane.	Specific gravity of juice from tops.
July 18	Flower stalks just out; compact......	2	6	4.3	2.4	......	3.32	2.64	......	......	82.39	83.00	82.70	.58	.57	1.15	34.6	1.046
July 26	Flower stalks begun to spread........	2	8.2	5.7	2.5	......	2.74	......	......	......	75.35	51.03	63.19	.49	.59	1.08	39.6	1.064
Aug. 7	Flower stalks spreading; seed milky..	2	5.1	2.8	2.3	.075	2.80	2.10	......	......	74.94	78.63	76.79	.46	.59	1.05	37.5	1.071
Aug. 11	Seed browning; harder................	2	5.4	2.9	2.5	.075	2.80	2.12	......	......	71.06	76.48	73.77	.47	.59	1.06	37.9	1.073
Aug. 13	Seed harder; stalk suckering.........	2	5.2	2.9	2.3	.063	3.14	2.12	......	......	70.70	69.62	70.16	.45	.55	1.00	31.9	1.082
Aug. 16	......do.............................	2	6.4	......	......	.075	3.64	2.30	......	......	89.96	72.17	80.07	.90	.69	1.59	32.7	1.081
Aug. 20	Seed nearly dry but crushable........	2	5.8	3.3	2.5	.068	3.02	2.14	......	......	....	....	....	.46	.57	1.03	33.8	1.081
Aug. 22	Seed hard but splitable..............	2	5.6	3.1	2.5	.075	3.52	2.48	......	......	....	....	....	.50	.60	1.10	31.3	1.077
Aug. 26	......do.............................	2	5.2	3.1	2.1	.083	4.52	2.84	......	......	....	71.97	....	.65	.76	1.41	26.9	1.081
Aug. 30	Core of cane turning red.............	2	5.3	......	......	.075	2.52	2.18	......	......	67.38	74.17	70.78	....	....	....	....	1.085
Sept. 8	Ripe; seed dry and mostly gone.......	2	5.1	2.9	2.2	.070	3.63	2.02	......	......	67.07	70.89	68.98	.388	.567	.955	26.2	1.087
Sept. 12	Ripe; seed carried away entirely.....	2	5.5	3.3	2.2	.060	3.56	1.79	.89	.90	68.47	76.48	72.47	.344	.379	.723	20.3	1.080
Sept. 12	Ripe and dry; carried away by birds..	2	5.1	3.2	1.9	.080	3.77	2.02	1.01	1.01	71.61	71.45	71.53	.425	.493	.918	24.3	1.081
Sept. 16	Ripe and dry.........................	2	5.5	3.4	2.1	.080	4.47	1.60	.90	.70	71.60	74.80	73.20	.487	.540	1.027	22.9	1.081
Sept. 22	......do.............................	5	5.2	......	......	.075	8.80	3.80	......	......	....	....	76.75	....	....	1.775	20.0	....
Oct. 3	......do.............................	2	5.5	3.4	2.1	.090	4.11	2.04	1.03	1.01	67.75	69.17	68.46	.467	.419	.886	21.5	1.076
Oct. 13	......do.............................	2	5.9	3.8	2.1	.070	3.77	1.75	.87	.88	68.47	70.94	69.70	.434	.406	.840	22.2	1.082
Oct. 20	......do.............................	2	5.7	3.4	2.3	.070	3.75	1.76	.82	.94	68.34	65.15	66.74	.337	.434	.771	21.2	1.085
Oct. 29	Leaves killed by frost...............	2	5.1	3.1	2.0	.090	3.03	1.80	.87	.93	68.31	70.45	69.38	.469	.540	1.009	33.3	1.092
Nov. 8	Quite dead...........................	2	5.9	3.7	2.2	.060	2.54	1.76	.83	.93	69.98	71.83	70.90	.318	.494	.812	31.9	1.084
	FOREIGN.																	
Sept. 11	Brown husks full of milk (D. Smith)..	2	6	......	......	.082	1.75	1.32	......	......	....	....	72.36	....	....	.513	29.2	....
Sept. 13	Just browning (Hutchinson)...........	2	6	3.7	2.3	.062	2.24	2.01	1.02	.99	78.95	84.82	81.88	.556	.538	1.094	48.8	1.039
Sept. 17	Between milk and dough (D. Smith)....	2	6.2	3.8	2.4	.062	1.72	1.27	.67	.60	73.79	72.93	73.36	.295	.317	.612	35.6	1.076
Sept. 13	In dough (Hutchinson)................	2	6	3.6	2.4	.062	2.10	1.50	.74	.76	75.83	68.27	72.05	.373	.377	.750	35.6	1.073

EARLY AMBER—Continued.

Date.	Development.	Specific gravity of juice from butts.	Average specific gravity of juice.	Per cent. of solids in juice from tops.	Per cent. of solids in juice from butts.	Per cent. of glucose in juice from tops.	Per cent. of glucose in juice from butts.	Per cent. of sucrose in juice from tops.	Per cent. of sucrose in juice from butts.	Average per cent. of glucose.	Average per cent. of sucrose.	Per cent. of solids (not sugar) in juice from tops.	Per cent. of solids (not sugar) in juice from butts.	Average per cent. of solids, not sugar.	Per cent. of sucrose in top by polarization.	Per cent. of sucrose in butt by polarization.	Average per cent. of sucrose by polarization.	Number of analysis.
July 18	Flower stalks just cut; compact	[illegible]	1.047	10.28	10.81	4.7	2.9	4.2	4.7	3.77	4.43	1.43	3.27	2.35	......	......	......	1, 2, 5, 6
July 26	Flower stalks begun to spread	1.061	1.064	14.13	12.07	3.9	2.4	7.8	8.0	3.14	7.85	2.44	2.71	2.57	......	......	......	13, 14
Aug. 7	Flower stalks spreading; seed milky	1.070	1.070	15.85	13.57	3.4	2.6	11.1	11.2	2.97	11.15	1.42	1.77	1.59	......	......	......	17, 18
Aug. 11	Seed browning; harder	1.080	1.079	17.62	17.50	3.0	1.7	13.6	14.0	2.36	13.78	1.06	1.80	1.43	......	......	......	25, 26
Aug. 13	Seed harder; stalk [illegible]	1.082	1.082	17.52	16.63	1.9	1.6	14.2	14.3	1.74	14.25	1.49	.75	1.12	......	......	......	29, 30
Aug. 16	......do	1.080	1.080	17.62	16.80	1.6	1.5	15.1	14.3	1.54	14.67	.91	1.09	1.00	......	......	......	37, 38
Aug. 20	Seed nearly dry but crushable	1.081	1.081	18.13	18.13	1.9	1.3	14.2	14.0	1.69	14.13	2.05	......	[illegible]	......	......	......	41, 42
Aug. 22	Seed hard but splitable	1.074	1.075	......	......	1.5	1.5	15.0	14.6	1.48	14.78	......	......	......	......	......	......	49, 50
Aug. 26	......do	[illegible]	1.079	......	16.12	1.3	1.3	14.6	14.3	1.31	14.45	......	.52	......	......	......	......	57, 58
Aug. 30	Core of cane turning red	1.074	1.079	19.89	17.23	1.2	1.5	14.8	14.7	1.33	14.72	3.92	1.02	2.47	......	......	......	65, 66
Sept. 8	Ripe; seed dry and mostly gone	1.075	1.081	20.58	17.35	.6	.8	9.4	7.5	.7	8.45	10.50	9.05	9.77	......	......	......	92, 93
Sept. 12	Ripe; seed carried away entirely	1.070	1.075	18.47	16.79	.6	.6	14.8	14.7	.6	14.75	3.07	1.49	2.28	......	......	......	90, 91
Sept. 12	Ripe and dry; carried away by birds	1.079	1.080	18.91	18.36	.7	.7	14.5	14.3	.7	14.4	3.71	3.36	3.53	......	......	......	109, 110
Sept. 16	Ripe and dry	1.079	1.080	18.82	18.70	.5	.8	16.1	15.8	.65	15.95	2.22	2.10	2.16	......	......	......	136, 137
Sept. 22	......do	......	1.079	17.67		.73	.78	14.9	14.7	.7	14.8	2.67	......	2.27	......	......	......	175, 176
Oct. 3	......do	1.070	1.073	18.63	17.27	.9	1.3	14.7	14.1	1.1	14.4	3.03	1.87	2.45	13.8	......	......	206, 207
Oct. 13	......do	[illegible]	1.081	......	18.93	.7	.7	15.9	15.7	.7	15.8	......	2.49	....	15.1	15.1	15.1	227, 228
Oct. 20	......do	[illegible]	[illegible]	20.89	20.75	1.0	.9	16.0	15.5	.95	15.75	3.89	4.35	4.12	15.1	15.2	15.15	251, 252
Oct. 29	Leaves killed by frost	[illegible]	1.088	21.69	20.76	.9	1.4	17.7	16.3	1.1	17.0	3.09	3.06	3.08	......	......	......	262, 263
Nov. 8	Quite dead	1.073	[illegible]	19.87	17.57	4.1	4.5	11.9	10.0	4.3	10.9	3.87	3.07	3.47	......	......	......	......
	[illegible]																	
Sept. 11	Brown husks full of milk (D. Smith)	......	1.078	19.36		3.2	......	......	......	3.2	12.1	......	......	4.66	......	......	......	83
Sept. 13	Just browning (Hutchinson)	1.081	1.085	9.20	8.40	3.7	3.4	4.6	2.4	3.5	3.5	.90	2.60	1.70	......	......	......	100, 101
Sept. 17	Between milk and dough (D. Smith)	1.070	1.073	18.54	17.30	2.9	3.8	12.2	12.3	3.35	12.25	3.44	1.20	2.32	......	......	......	111, 112
Sept. 13	In dough (Hutchinson)	1.071	1.072	18.37	17.76	2.1	3.6	12.3	8.8	2.85	10.55	3.97	5.36	4.66	......	......	......	98, 99

CHINESE.

Date.	Development.	Number of stalks used for anal.	Length of topped stalk, in feet.	Length of top, in feet.	Length of butts.	Diameter of butt, in feet.	Weight of stalk, in pounds.	Weight of stalk stripped, in pounds.	Weight of top, in pounds.	Weight of butt, in pounds.	Per cent. of water in top.	Per cent. of water in butt.	Average per cent. of water in cane.	Weight of juice from tops, in pounds.	Weight of juice from butts, in pounds.	Total weight, juice, in pounds.	Per cent. of juice on entire cane.	Specific gravity of juice from tops.
Aug. 6	Flower stalk just out; compact	2	4.8	2.7	2.1	.063	2.72	1.82	......	......	83.03	....	....	.430	.440	.870	......	1.033
Aug. 6	Flower spreading a little	2	8.1	5.8	2.3	.083	4.10	2.82	......	......	83.55	84.42	83.99	.630	.710	1.340	32.7	1.044
Aug. 12	Seeds beginning to brown	2	5.7	3.3	2.4	.083	3.60	2.52	......	......	79.17	84.15	81.66	.540	.670	1.210	33.7	1.061
Aug. 19	Seeds browner	2	6.4	4.4	2.2	.075	3.58	2.22	......	......	74.49	83.05	78.77	.450	.570	1.020	29.0	1.067
Aug. 29	Seeds soft but not milky	2	6.6	4.4	2.2	.075	3.28	2.28	......	......	67.88	70.81	69.35	.430	.490	.920	28.2	1.074
Sept. 8	Seeds still green in parts and milky	2	5.8	3.5	2.3	.093	5.62	3.55	......	......	71.84	76.46	74.15	.769	.944	1.713	30.4	1.073
Sept. 13	Seeds dropping and hard	1	7.1	4.7	2.4	.100	2.86	1.82	.91	.91	70.01	72.54	71.27	.395	.410	.805	28.1	1.085
Sept. 20	Seeds nearly gone	2	5.7	3.6	2.1	.079	4.17	2.43	1.21	1.22	76.98	72.21	74.09	.571	.586	1.157	27.7	1.082
Sept. 27	......do	2	4.9	2.9	2.0	.082	3.27	1.89	.93	.96	70.75	75.04	72.89	.417	.417	.834	25.5	1.081
Oct. 3	Dry and ripe	2	5.8	3.86	1.9	.082	4.10	2.23	1.31	.92	76.10	66.61	71.35	.516	.490	1.006	24.5	1.086
Oct. 14	......do	2	6.0	4.0	2.0	.088	4.49	2.29	1.08	1.21	66.55	73.00	69.77	.476	.670	1.146	25.5	1.081
Oct. 21	Dry and ripe; red juice	2	6.1	4.0	2.1	.081	4.43	2.35	1.05	1.30	69.88	71.93	70.90	.428	.553	.981	22.1	1.077
Oct. 29	Dry, and leaves killed by frost	2	5.2	3.2	2.0	.075	3.65	2.26	1.03	1.23	67.87	71.15	69.51	.553	.578	1.131	31.0	1.076
Nov. 8	Quite dead	2	5.6	3.6	2.0	.088	3.21	2.30	1.05	1.25	70.09	74.36	72.22	.511	.657	1.168	36.4	1.086
	FOREIGN.																	
Sept. 11	Seed just forming (D. Smith)	2	7.4	4.6	2.8	.083	2.84	2.30	1.16	1.14	....	....	75.07	....	....	.814	28.7	......
Sept. 17	Seed just browning (D. Smith)	2	7.4	5.3	2.1	.062	1.68	1.31	.65	.65	71.62	72.59	72.10	.315	.309	.624	37.1	1.065
Sept. 30	Seed in the milk	3	6.1	......	......	.059	2.52	1.88	......	......	73.39	72.39	72.89	.328	.368	.696	27.6	1.079
Oct. 8	Seed in dough	2	6.4	3.6	2.8	.065	3.09	2.26	1.06	1.20	68.55	70.63	69.59	.457	.494	.951	30.8	1.052

CHINESE.

Date.	Development.	Specific gravity of juice from butts.	Average specific gravity of juice.	Per cent. solids in juice from tops.	Per cent. solids in juice from butts.	Per cent. glucose, tops.	Per cent. glucose, butts.	Per cent. sucrose, tops.	Per cent. sucrose, butts.	Average per cent. glucose.	Average per cent. sucrose.	Solids not sugar, in juice, from tops.	Solids not sugar, in juice, from butts.	Average per cent. solids not sugar, in juice.	Per cent. sucrose by polarization, tops.	Per cent. sucrose, by polarization, butts.	Average per cent. sucrose by polarization.	Number of analysis.
Aug. 6	Flower stalk just out, compact	1.041	1.037	6.87	8.83	5.9	5.2	1.0	2.7	5.55	1.85	......	.92	......	......	......	......	9-10
Aug. 6	Flower spreading a little	1.048	1.046	9.62	9.84	6.2	6.3	2.7	3.4	6.1	3.05	1.2	.14	.13	......	......	......	11-12
Aug. 12	Seeds beginning to brown	1.057	1.059	12.70	12.09	5.2	4.2	6.3	6.3	4.6	6.3	1.2	.59	.89	......	......	......	21-2
Aug. 19	Seeds browner	1.063	1.065	14.60	12.12	4.6	5.9	7.1	5.8	5.25	6.45	2.3	.42	1.36	......	......	......	33-4
Aug. 29	Seeds soft but not milky	1.072	1.073	15.73	15.14	3.6	3.2	12.9	11.4	3.4	12.15	......	.54	......	......	......	......	53-4
Sept. 8	Seeds still green in parts and milky	1.071	1.072	17.79	18.01	1.7	2.8	10.5	7.6	......	......	......	......	......	......	......	......	67-8
Sept. 13	Seeds dropping and hard	1.081	1.083	20.21	22.33	.9	2.0	15.2	12.6	1.45	13.9	4.11	5.73	4.92	......	......	......	96-7
Sept. 20	Seeds nearly gone	1.081	1.081	20.21	17.52	1.4	2.6	14.2	13.3	2.0	13.75	......	.62	......	......	......	......	132-3
Sept. 27	......do	1.081	1.081	16.43	18.20	1.2	1.7	14.6	14.4	.95	14.50	2.63	2.33	.48	......	15.2	......	147-8
Oct. 3	Dry and ripe	1.079	1.082	20.44	23.73	1.6	3.2	11.4	11.9	2.4	11.65	7.41	8.63	8.03	15.3	13.5	14.4	179-80
Oct. 14	......do	1.082	1.081	18.61	19.11	1.3	1.9	14.7	15.4	1.6	15.05	2.61	1.81	2.21	14.2	15.2	14.7	213-4
Oct. 21	Dry and ripe, red juice	1.077	1.077	18.37	19.60	1.3	1.5	13.8	15.5	1.4	14.85	3.27	2.60	2.93	......	......	......	232-3
Oct. 29	Dry, and leaves killed by frost	1.077	1.076	17.83	18.51	2.1	1.6	12.5	13.8	1.85	13.15	3.23	2.43	2.83	......	......	......	253-4
Nov. 8	Quite dead	1.082	1.084	19.61	19.39	4.8	2.8	12.3	14.3	3.8	13.3	2.51	2.29	2.40	......	......	......	264-5
	FOREIGN.																	
Sept. 11	Seed just forming (D. Smith)	......	1.065	15.28		......	......	......	......	6.3	6.9	......	......	2.08	......	......	......	84-5
Sept. 17	Seed just browning (D. Smith)	1.058	1.061	15.59	14.37	6.9	7.7	6.9	6.6	7.3	6.7	1.79	.17	.98	......	......	......	116-7
Sept. 30	Seed in the milk	1.075	1.077	19.04	17.89	11.0	13.2	8.1	6.0	12.1	7.0	......	......	......	4.9	3.2	4.99	165-6
Oct. 8	Seed in dough	1.073	1.080	15.16	19.05	7.8	10.1	9.3	7.5	8.5	8.8	......	1.45	......	7.2	5.2	6.2	191-2

LIBERIAN.

Date.		Development.	Number of stalks used for analysis.	Length of stalk, in feet.	Length of top, in feet.	Length of butt, in feet.	Diameter at butt, in feet.	Weight of stalk, in pounds.	Weight of stripped stalk.	Weight of top, in pounds.	Weight of butt, in pounds.	Per cent. of water in top.	Per cent. of water in butt.	Average per cent. water in cane.	Weight of juice from tops, in pounds.	Weight of juice from butts, in pounds.	Total weight of juice, in pounds.	Per cent. of juice in entire cane.	Specific gravity of juice from tops.
July	18	Flower-stalk just out and compact..	2	6.1	3.5	2.6	....	3.28	2.62	......	....	83.79	83.31	83.55	.60	.59	1.19	36.4	1.046
	26	Flower-stalk spreading; seed milky.	2	8.2	5.7	2.5	.083	2.64	2.52	......	....	79.71	78.93	79.32	.49	.60	1.09	38.5	1.043
Aug.	7	Flower-stalk more spreading; seed milky.	2	5.4	2.5	2.9	......	2.76	2.52	......	....	75.75	78.36	77.06	.45	.71	1.16	....	1.061
	11	Seed browning; harder	2	5.8	3.0	2.8	......	3.42	2.66	......	....	72.79	76.36	74.58	.48	.62	1.10	31.7	1.079
	13	Seed harder	2	5.8	3.6	2.2	.063	3.52	2.58	......	....	70.98	75.73	73.36	.66	.70	1.36	33.2	1.081
	16	Juice brown in color................	2	8.0	5.7	2.3	.075	3.80	2.40	......	....	71.96	72.00	71.98	.59	.62	1.21	31.0	1.087
	20	Seed as before	2	8.2	5.7	2.5	.075	3.98	2.34	......	....	69.77	73.31	71.54	.50	.65	1.15	28.9	1.085
	22	Seed almost dry	2	5.5	......	......	......	4.14	2.62	......	....	....	75.91	....	.59	.62	1.21	29.2	1.083
	26	......do	2	5.3	3.1	2.2	.078	4.16	2.44	......	....	69.37	....	....	.58	.64	1.22	29.5	1.085
	30	Butt turned red at center..........	2	4.9	2.6	2.3	.075	3.76	......	......	....	70.21	72.47	71.34	....	....	....	....	1.080
Sept.	8	Ripe; seed dry	1	6.5	3.9	2.6	.072	2.10	1.26	......	....	70.30	71.42	70.86	.289	.295	.584	27.8	1.083
	13	Ripe; seed carried off by birds.....	2	5.5	2.75	2.25	.062	4.18	2.12	1.12	1.00	70.30	85.06	77.68	.453	.437	.890	21.3	1.082
	15	Ripe and dry	2	5.5	2.75	2.25	.062	4.04	2.01	1.02	.99	70.98	71.84	71.41	.494	.399	.893	22.1	1.081
	20	......do	2	5.2	3.20	2.0	.088	3.66	2.19	1.13	1.06	75.00	75.56	75.28	.542	.556	1.098	21.1	1.076
	27	Ripe and dry; largely suckered.....	2	6.07	3.71	2.36	.088	4.59	2.32	1.17	1.15	70.00	72.01	71.00	.445	.529	.974	21.2	1.071
Oct.	3	......do	2	5.08	2.95	2.13	.075	3.20	1.81	.92	.89	71.72	76.10	73.91	.423	.426	.849	26.6	1.078
	13	Ripe and dry; juices bright red.....	2	5.08	3.05	2.03	.072	3.33	1.61	.82	.79	69.22	71.68	70.45	.388	.362	.750	22.5	1.070
	21	Juices bright red	2	5.74	3.38	2.36	.072	3.36	1.84	.97	.97	65.65	80.49	73.07	.346	.406	.752	22.6	1.068
	29	Leaves killed by frost	2	5.08	3.05	2.03	.069	2.49	1.57	.78	.79	67.24	72.08	69.66	.344	.375	.719	28.8	1.082
Nov.	8	Quite dead............................	2	4.43	2.46	1.97	.079	2.18	1.21	.58	.63	69.89	71.46	70.17	.322	.323	.646	29.6	1.084
		FOREIGN.																	
Sept.	17	Seed just brown; not in milk	1	7.20	4.54	2.66	.083	2.67	2.10	1.01	1.09	74.93	78.41	76.67	.461	.428	.889	33.2	1.055
Oct.	1	Browning, but not much milk	2	6.63	4.17	2.46	.085	2.77	2.26	1.14	1.12	72.64	71.54	72.09	.426	.461	.887	32.0	1.070
	8	Brown and in milk....................	2	7.54	4.75	2.79	.092	4.01	3.12	1.44	1.68	74.73	75.06	74.89	.662	.792	1.454	36.2	1.074
	24	Brown and hard	2	7.54	4.69	2.85	.075	3.45	2.71	1.34	1.37	61.47	71.02	66.24	.423	.527	.950	27.5	1.088

LIBERIAN—Continued.

Date.		Development.	Specific gravity of juice from butts.	Average specific gravity of juice.	Per cent. solids in juice from tops.	Per cent. solids in juice from butts.	Per cent. of glucose in juice from tops.	Per cent. of glucose in juice from butts.	Per cent. of sucrose in juice from tops.	Per cent. of sucrose in juice from butts.	Average per cent. glucose in juice.	Average per cent. sucrose in juice.	Solids not sugar in juice from tops.	Solids not sugar in juice from butts.	Solids not sugar, average.	Per cent. of sucrose by polariscope in juice of tops.	Per cent. of sucrose by polariscope in juice of butts.	Average per cent. polariscope.	Number of analysis.
July	18	Flower-stalk just out and compact	1.048	1.047	9.87	10.75	5.2	3.0	4.6	6.9	4.1	5.7	.09	.83	.46	....	......	....	3, 4
	26	Flower-stalk spreading; seed milky	1.018	[illegible]	8.97	10.10	4.9	2.9	4.1	5.3	3.5	4.7	.72	1.87	1.30	....	......	....	7, 8
Aug.	7	Flower-stalk more spreading; seed milky.	1.066	1.064	14.76	14.53	3.6	2.8	10.0	11.9	3.2	11.0	1.14	......	......	....	......	....	15, 16
	11	Seed browning; harder	1.077	[illegible]	17.66	17.14	2.8	1.9	13.4	12.4	2.4	12.9	1.49	2.78	2.14	....	......	....	19, 20
	13	Seed harder	1.081	[illegible]	17.45	17.64	2.2	1.7	13.4	14.2	2.0	13.8	1.78	1.75	1.77	....	......	....	27, 28
	16	Juice brown in color	1.083	[illegible]	18.81	18.81	1.2	1.4	13.8	14.7	1.3	14.3	3.84	2.70	3.27	....	......	....	31, 32
	20	Seed as before	1.080	1.083	18.90	17.64	1.6	1.5	15.2	13.7	1.5	14.4	2.12	2.49	2.31	....	......	....	39, 40
	22	Seed almost dry	1.081	[illegible]	......	......	1.4	1.4	15.3	14.0	1.4	14.7	....	......	......	....	......	....	43, 44
	26	...do	1.077	1.082	17.95	15.69	1.3	1.4	14.1	13.4	1.4	13.7	2.59	.82	1.21	....	......	....	51, 52
	30	Butt turned red at center	1.080	[illegible]	19.10	......	.8	1.2	12.4	12.1	1.0	12.2	4.00	......	......	....	......	....	59, 60
Sept.	8	Ripe; seed dry	1.081	1.082	20.11	19.35	.7	.8	8.7	10.3	.75	8.35	10.71?	8.25	9.48	....	......	....	69, 70
	13	Ripe; seed carried off by birds	1.081	1.080	19.33	19.40	.5	.6	......	16.4	.55	....	....	2.40	......	....	......	....	94, 95
	15	Ripe and dry	1.080	[illegible]	18.95	18.40	.6	.7	11.3	13.9	.65	12.6	7.05	3.80	5.42	....	......	....	102, 103
	20	...do	1.073	1.075	17.12	[illegible]	.6	1.0	14.4	14.1	.8	14.25	2.12	.87	1.49	....	......	....	130, 131
	27	Ripe and dry; largely suckered	1.082	1.078	[illegible]	18.32	.7	1.2	15.3	14.6	.95	15.2	.55	2.52	1.53	14.1	15.3	14.7	145, 146
Oct.	3	...do	1.072	1.075	19.14	16.81	1.1	1.1	14.6	13.7	1.1	14.15	3.44	2.04	2.74	13.9	13.4	13.65	177, 178
	13	Ripe and dry; juices bright red	1.074	1.077	19.08	17.62	.9	1.0	14.7	13.4	.95	14.05	3.48	3.22	3.35	14.15	......	....	208, 209
	21	Juices bright red	1.068	1.068	16.37	16.31	1.1	1.1	11.1	12.5	1.1	11.8	4.17	2.81	3.49	....	......	....	230, 231
	29	Leaves killed by frost	1.079	[illegible]	19.48	19.49	1.5	2.7	14.3	13.5	2.1	13.9	3.68	3.29	3.48	....	......	....	255, 256
Nov.	8	Quite dead	1.070	1.077	18.86	15.75	2.9	5.2	12.8	8.4	4.0	10.6	3.16	2.15	2.65	....	......	....	266, 267
		[illegible]																	
Sept.	17	Seed just brown; not in milk	1.051	1.052	13.25	12.94	4.9	7.2	7.4	5.2	6.05	6.2	.95	.54	.74	....	......	....	117, 118
Oct.	1	Browning, but not much milk	1.068	1.069	16.77	16.24	8.9	9.9	8.2	7.1	8.55	8.50	....	......	......	....	......	....	167, 168
	8	Brown and in milk	1.065	1.069	18.16	17.64	4.9	8.3	11.6	......	6.65	....	....	......	......	....	......	....	189, 190
	24	Brown and hard	1.087	1.087	16.77	21.12	2.3	3.9	17.2	16.8	3.1	17.00	....	.42	......	....	......	....	241, 242

HONDURAS.

Date.		Development.	Number of stalks used for analysis.	Length of topped stalk, in feet.	Length of top in feet.	Length of butt, in feet.	Diameter at butt, in feet.	Weight of whole stalk, in pounds.	Weight of stalk stripped, in pounds.	Weight of top, in pounds.	Weight of butt, in pounds	Per cent. of water in top	Per cent of water in butt.	Average per cent. of water in stock.	Weight of juice from tops, in pounds.	Weight of juice from butts, in pounds.	Total weight of juice, in pounds.	Per cent. of juice in entire cane.	Specific gravity of juice from tops.	Specific gravity of juice from butts.
Aug	12	No sign of flower-stalk; cane 7 ft. high	2	5.8	......	......	......	6.76	5.02	......	......	......	83.99	....	1.17	1.15	2.32	31.4	1.032	1.037
	19	Flower-stalk just out	2	7.2	4.2	2.9	.104	7.34	5.48	......	......	82.83	84.15	83.99	1.26	1.42	2.68	36.5	1.037	1.042
	29	Flower-stalk spreading	2	9.1	......	......	.104	7.48	5.93	......	......	85.09	79.67	81.33	1.18	1.85	3.03	37.7	1.040	1.045
Sept.	10	Stamens just fallen; no milk	1	10.1	6.2	3.8	.093	3.21	2.57	......	......	73.51	81.53	77.52	.564	.677	1.241	38.6	1.047	1.050
	10	Beginning to brown	1	9.5	6.1	3.4	.125	3.85	2.88	1.25	1.63	80.51	81.73	81.12	.670	.765	1.435	37.2	1.056	1.051
	15	In first milk; browning	1	9.7	7.5	2.2	.114	4.32	3.33	1.58	1.75	75.29	80.29	77.79	.730	.811	1.541	35.6	1.057	1.054
	19	In milk; brown	1	9.1	5.8	3.3	.093	2.76	1.98	1.02	.96	75.00	75.78	75.39	.426	.427	.853	30.9	1.057	1.057
	25	Full milk	1	9.8	6.6	3.2	.098	3.21	2.53	1.17	1.36	77.03	80.26	78.64	.542	.670	1.212	37.1	1.059	1.057
	29	...do	1	9.2	6.0	3.2	.115	4.08	2.90	1.27	1.63	76.10	77.10	76.60	.525	.717	1.212	30.4	1.060	1.061
Oct.	4	Dough	1	9.9	6.4	3.5	.121	4.03	3.00	1.35	1.65	72.52	75.52	74.02	......	.743	....	......	1.070	1.066
	11	...do	1	10.8	7.2	3.6	.112	4.28	2.94	1.39	1.55	64.15	69.19	66.62	.520	.642	1.162	28.4	1.074	1.070
	20	Harder	1	10.5	7.0	3.5	.112	3.75	2.79	1.29	1.50	68.27	70.52	69.39	.503	.644	1.147	30.6	1.080	1.079
	29	Harder; leaves dead	1	10.3	6.7	3.6	.088	3.78	2.92	1.23	1.69	68.85	74.09	71.42	.536	.633	1.169	31.5	1.077	1.074
Nov.	8	Quite dead	1	10.2	6.7	3.5	.105	3.09	2.69	1.25	1.41	60.21	72.27	70.71	.556	.759	1.315	43.5	1.086	1.075
		FOREIGN.—P. SMITH.																		
Sept.	17	Not brown nor milky; heads well out	1	8.3	5.4	2.9	.114	1.75	1.49	.70	.79	67.22	76.55	71.88	.276	.373	.649	25.0	1.047	1.044
Oct.	1	Young; flower-tops spreading	2	10.8	8.2	2.6	[illegible]	2.53	2.07	1.02	1.05	69.46	63.96	66.71	.284	.392	.676	26.2	1.066	1.058
	8	Browning	2	9.0	6.1	2.9	.125	5.81	4.48	2.03	2.45	57.39	76.72	67.05	.860	1.036	1.896	32.6	1.075	1.062
	21	Tall stalk; seed first milk	1	7.7	4.6	3.1	.115	3.08	2.61	1.30	1.31	75.77	74.35	75.06	.624	.751	1.375	44.7	1.075	1.070
	21	Shorter and more stalky and riper	2	6.2	3.9	2.3	.092	2.83	1.85	.87	.98	63.04	62.35	62.69	.247	.351	.598	21.1	1.055	1.059
		ARSENAL.																		
Sept.	30	Seeds not filled out	1	8.2	5.0	3.2	.092	2.19	1.81	.85	.96	79.49	78.10	78.75	.445	.529	.974	44.4	1.050	1.052
Oct.	15	Seeds greenish brown	1	9.7	5.9	3.8	.102	2.15	1.79	.77	1.02	76.81	....	....	.373	.531	.904	42.0	1.054	1.054

HONDURAS—Continued.

Date.		Development.	Average specific gravity of juice.	Per cent. solids in juice from tops.	Per cent. solids in juice from butts.	Average per cent. solids in juice.	Per cent. glucose in juice of tops.	Per cent. glucose in juice of butts.	Per cent. sucrose in juice of tops.	Per cent. sucrose in juice of butts.	Average per cent. glucose in juice from cane.	Average per cent. sucrose in juice from cane.	Solids not sugar in juice from tops.	Solids not sugar in juice from butts.	Average per cent. solids not sugar in juice.	Per cent. sucrose by polariscope, tops.	Per cent. sucrose by polariscope in juice of butts.	Average per cent. sucrose by polariscope in juice.	Number of analysis.
Aug.	12	No sign of flower-stalk; cane 7 feet high..	1.035	6.04	6.97	6.50	4.10	6.2	1.7	.8	5.13	1.2	.24	......	......	......	......	......	....
	19	Flower-stalk just out	1.040	7.63	8.46	8.04	5.4	5.0	2.2	3.4	5.20	3.8	.03	......	......	......	......	......	....
	29	Flower-stalk spreading	1.043	8.27	9.44	8.80	4.9	5.1	4.0	4.4	5.00	4.2	....	......	......	......	......	......	....
Sept.	10	Stamens just fallen; no milk	1.058	Burned.	....	....	3.4	4.0	6.2	5.7	3.7	5.9	....	......	......	......	......	......	75–76
	10	Beginning to brown	1.053	12.21	11.32	11.76	3.5	4.1	7.9	6.7	3.8	7.3	....	......	......	......	......	......	77–78
	15	In first milk; browning	1.055	13.66	12.56	13.11	3.7	4.0	8.9	8.0	3.8	8.4	1.06	.56	.81	......	......	......	104–5
	19	In milk; brown	1.057	13.82	14.60	14.21	2.8	3.1	8.5	8.7	2.9	8.6	2.52	2.80	2.66	......	......	......	127–8
	25	Full milk	1.058	13.31	13.23	13.27	2.9	3.8	9.4	8.2	3.3	8.8	1.01	1.23	1.12	9.55	8.7	9.1	143–4
	29	....do	1.069	13.92	14.20	14.06	2.4	3.3	10.6	10.4	2.8	10.5	.92	.50	.71	10.0	10.1	10.0	153–4
Oct.	4	Dough	1.068	17.09	16.61	16.85	2.2	3.5	13.0	11.6	2.8	12.3	1.89	1.51	1.70	12.2	10.7	11.4	181–2
	14	....do	1.072	17.48	17.72	17.60	1.0	1.8	14.6	14.4	1.4	14.5	1.83	1.22	1.55	13.7	14.0	13.8	211–12
	20	Harder	1.079	22.78	19.40	21.09	1.2	1.4	14.9	15.4	1.3	15.1	7.63?	2.60	5.10	......	......	......	225–26
	29	Harder; leaves dead	1.075	17.67	17.88	17.77	1.1	1.9	15.0	13.5	1.5	14.2	1.57	2.48	2.02	......	......	......	249–50
Nov.	3	Quite dead	1.080	19.54	17.35	18.44	3.9	3.1	13.4	12.7	3.5	13.0	2.24	1.55	1.89	......	......	......	268–69
		FOREIGN.—D. SMITH.																	
Sept.	17	Not brown nor milky; heads well out	1.045	10.77	10.49	10.63	5.6	5.7	3.6	3.6	5.6	3.6	1.52	1.19	1.35	......	......	......	119–20
Oct.	1	Young; flower-tops spreading	1.062	11.96	13.25	12.60	10.9	11.4	3.4	3.7	11.1	3.6	....	......	......	1.0	.7	.8	163–4
	8	Browning	1.068	12.77	14.68	13.72	6.8	8.1	5.6	5.7	7.4	5.6	.37	.88	.62	4.2	4.2	4.2	187–8
	21	Tall stalk; seed first milk	1.072	18.14	17.17	17.65	4.3	6.5	13.0	10.7	5.4	11.8	.84	......	......	......	......	......	237–8
	24	Shorter and more stalky and riper........	1.067	14.34	14.05	14.19	4.6	6.4	7.1	5.8	5.5	6.4	2.64	.85	1.74	......	......	......	239–40
		ARSENAL.																	
Sept.	30	Seeds not filled out	1.051	11.73	13.01	12.37	8.0	7.1	3.1	5.4	7.5	4.2	1.91	......	......	1.1	3.9	2.5	155–6
Oct.	15	Seeds greenish brown	1.054	....	13.74	....	7.5	8.8	4.5	4.1	8.1	4.3	....	.84	......	......	......	......	217–8

MISCELLANEOUS SORGHUMS.

Date.	Variety.	Development.	Number of stalks.	Length of topped stalk, in feet.	Length of top, in feet.	Length of butt, in feet.	Diameter at butt, in feet.	Weight of stalk, in pounds.	Weight of stripped stalk, in pounds.	Weight of top, in pounds.	Weight of butt, in pounds.	Per cent. of water in top.	Per cent. of water in butt.	Average per cent. of water in cane.	Pounds of juice from tops.	Pounds of juice from butts.	Total weight of juice, in pounds.	Per cent. of juice in entire cane.	Specific gravity of juice tops.
Sept. 9	Gunnison	Green suckers	2	5.7	3.3	2.4	.073	3.74	1.91	......	......	69.42	75.69	72.55	.461	.472	.933	24.9	1.079
Sept. 9	....do	Dry suckers	2	5.4	3.1	2.3	.073	4.21	2.21	......	......	71.39	73.63	72.51	.545	.515	1.060	25.1	1.078
Sept. 16	....do	Green suckers	2	5.5	3.3	2.2	.083	4.24	2.13	1.03	1.10	81.25	72.48	76.86	.483	.553	1.036	24.4	1.079
Sept. 20	....do	Very ripe and dry	2	5.7	3.6	2.1	.079	4.13	2.02	1.03	.99	71.33	70.80	71.06	.512	.459	.971	23.5	1.082
Sept. 27	....do	......do	2	4.5	2.5	2.0	.075	4.00	1.77	1.87	.90	71.67	70.15	70.91	.401	.467	.862	21.5	1.077
Oct. 10	Mastodon	......	1	14.76	10.82	3.94	0.180	......	6.46	3.23	3.23	77.73	78.67	78.20	1.665	1.720	3.385	......	1.071
Oct. 10	Imphee	......	1	8.8	......	......	.112	2.12	1.93	......	......	......	......	75.24	......	......	1.074	50.6	......
Oct. 10	Black Top	......	1	10.5	......	......	.092	1.53	1.42	......	......	......	......	71.34	......	......	.746	48.7	......
Oct. 10	Oomseeana	......	1	7.3	......	......	.079	1.37	1.19	......	......	......	......	74.84	......	......	.606	44.2	......

Date.	Variety.	Development.	Specific gravity of juice from butts.	Average specific gravity of juice.	Per cent. solids in juice from tops.	Per cent. solids in juice from butts.	Tops, juice from, per cent. of glucose.	Butts, juice from, per cent. of glucose.	Tops, juice from, per cent. of sucrose.	Butts, juice from, per cent. of sucrose.	Average per cent. of glucose in juice of cane.	Average per cent. of sucrose.	Solids, not sugar, in juice from tops.	Solids, not sugar, in juice of butts.	Average of solids, not sugar, in juice.	Sucrose in juice from tops by polarization.	Sucrose in juice from butts by polarization.	Average sucrose in juice by polarization.	Number of analysis.
Sept. 9	Gunnison	Green suckers	1.077	1.078	13.97	15.55	.7	.5	9.3	9.9	.6	9.6	5.55	4.36	4.95	......	......	......	71, 72
Sept. 9	....do	Dry suckers	1.076	1.077	17.31	......	.9	1.0	11.6	13.2	.9	12.4	4.81	......	......	......	......	......	73, 74
Sept. 16	....do	Green suckers	1.082	1.080	18.38	18.67	.6	.6	12.6	13.9	.6	13.2	5.18	4.17	4.62	......	......	......	107, 108
Sept. 20	....do	Very ripe and dry	1.080	1.081	18.77	18.11	.7	.7	15.6	15.1	.7	15.3	2.37	2.64	2.50	......	......	......	134, 135
Sept. 27	...do	......do	1.078	1.077	18.24	18.72	.7	.6	15.2	15.9	.6	15.5	2.34	2.08	2.21	......	......	......	149, 150
Oct. 10	Mastodon	......	1.064	1.067	16.92	15.41	1.3	5.8	14.7	8.8	3.5	11.7	.92	.31	.86	......	......	......	......
Oct. 10	Imphee	......	......	1.068	......	......	......	......	......	......	9.1	6.9	......	......	.28	10.5	6.1	8.3	198, 199
Oct. 10	Black Top	......	......	1.084	......	......	......	......	......	......	4.5	13.6	......	......	1.74	......	......	4.7	200
Oct. 10	Oomseeana	......	......	1.077	......	......	......	......	......	......	2.3	14.4	......	......	1.70	......	......	11.9	201

PEARL MILLET.

Date.		Development.	Number of stalks for analysis.	Length of topped stalks, in feet.	Diameter at butts, in feet.	Weight of whole stalk, in pounds.	Weight of stripped stalk, in pounds.	Per cent. of water in cane.	Weight of juice, in pounds.	Per cent. of juice in stalks.	Specific gravity of juice.	Per cent. of solids in juice.	Per cent. of glucose in juice.	Per cent. of sucrose in juice.	Per cent. of solids, not sugar, in juice.	Polarization.	Number of analysis.
pt.	10	Stamens still on	2	5.7	.062	1.67	1.12	Burned	.505	30.0	1.035	Burned	1.6	3.7	......	......	79, 80
pt.	10	Stamens fallen	2	6.7	.062	1.57	1.04	..do ...	.480	30.5	1.034	..do ...	1.6	1.9	......	......	81, 82
pt.	16	No change in appearance	2	5.3	.073	2.00	1.02	76.31	.373	18.6	1.049	11.17	.8	7.3	3.07	......	106
pt.	19	... do	2	5.1	.062	1.78	1.[illegible]	76.98	.406	22.8	1.049	11.53	1.5	7.0	3.63	......	129
pt.	25	Dry tops; suckering	3	5.7	.065	2.50	1.49	72.00	.547	21.5	1.051	11.09	1.1	8.7	1.29	......	142
pt.	29	.....do	3	6.6	.065	3.00	2.08	75.53	.783	26.1	1.060	11.21	1.2	9.6	.41	......	152
t.	4	Dry tops; suckers well developed	2	5.1	.056	2.09	.98	67.35	.529	25.3	1.061	14.10	1.3	10.1	2.70	......	183
t.	14	Leaves dead and yellow	2	6.1	.07[illegible]	1.85	.97	61.41	.377	20.3	1.068	15.30	2.0	11.3	2.00	......	215
t.	20	Frost-withered	2	6.1	.072	1.65	1.06	65.65	.560	33.9	1.058	13.15	3.0	6.7	3.45	......	229
t.	29	Quite dead	3	5.6	.059	1.53	.88	72.54	.337	22.0	1.070	16.18	5.4	7.4	3.35	......	248
		FOREIGN.															
t.	21	Withered	2	5.3	.059	1.20	.77	75.77	.302	25.1	1.058	18.14	.5	11.7	5.91	......	243

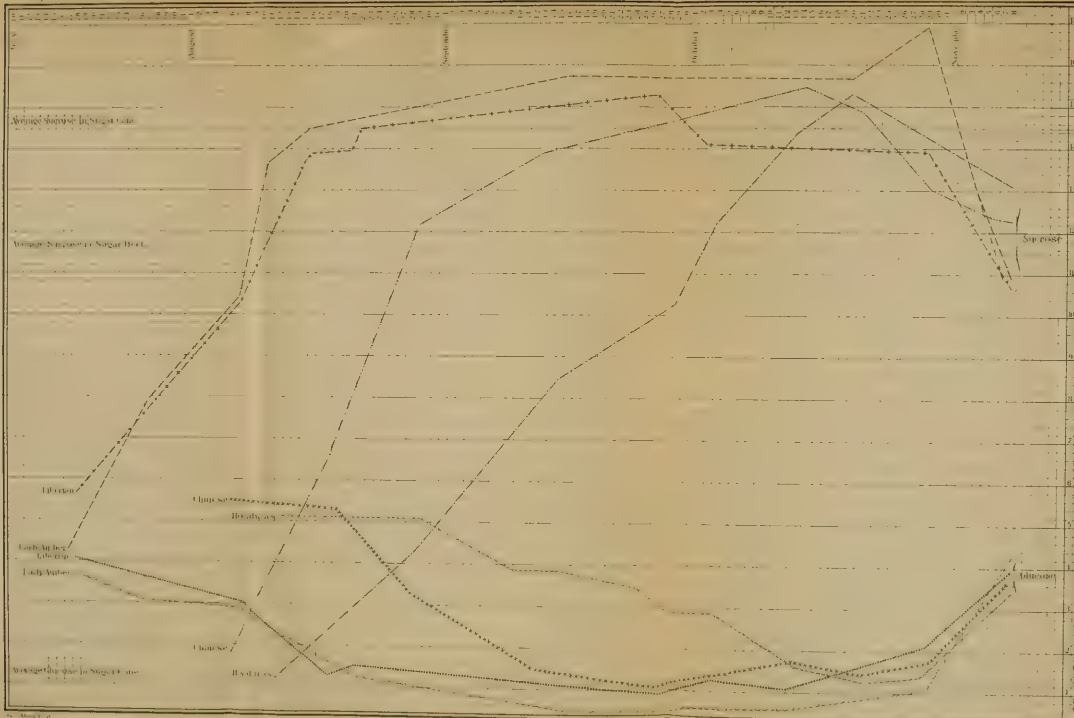
MISCELLANEOUS.

Date.	Variety.	Development.	Number of stalks.	Length of topped stalk, in feet.	Length of top, in feet.	Length of butt, in feet.	Diameter of butt, in feet.	Weight of stalk, in pounds.	Weight of stalk stripped, in pounds.	Weight of top, in pounds.	Weight of butt, in pounds.	Per cent. of water in top.	Per cent. of water in butt.	Average per cent. of water in cane.	Weight of juice from tops, in pounds.	Weight of juice from butts, in pounds.	Total weight of juice, in pounds.	Per cent. of juice in entire cane.	Specific gravity of juice, tops.
Sept. 17	Egyptian Corn		3	4.9	3.0	1.9	.083	2.70	1.85	.90	.95	84.09	85.03	84.51	.329	.493	.822	30.4	1.010
Sept. 11	...do		2	4.4	2.9	1.5	.083		1.44	.58	.86	76.44	76.06	76.25	.267	.375	.642	..	1.062
Sept. 17	Fodder		2	6.5	4.4	2.1	.083	2.42	1.71	.77	.94	78.96	79.27	78.66	.332	.505	.837	34.6	1.035
Sept. 11	Brown Doura		2	3.2			.041	.82	.30					70.83			.081	9.8	
Oct. 1	...do		3	3.7			.049	1.58	.59					66.54			.095	6.0	
Sept. 11	White Doura		2	5.2			.062	1.45	.92					51.56			.207	14.2	
Oct. 1	...do		3	4.3			.049	1.58	.59								.097	6.1	
Aug. 23	Corn	Two weeks before plucking ears	3	5.7	3.5	2.2	.068	5.88	3.87			77.34	77.05	77.20	.460	.520	.980	21.8	1.046
Aug. 23	...do	At time of plucking ears	3	4.4	2.8	1.6	.088	6.36	3.63			73.94			.430	.670	1.190	26.0	1.051

Date.	Variety.	Development.	Specific gravity of juice, butts.	Average specific gravity.	Per cent. solids in juice from tops.	Per cent. solids in juice from butts.	Tops, glucose.	Butts, glucose.	Tops, sucrose.	Butts, sucrose.	Average glucose in juice from cane.	Average sucrose in juice from cane.	Solids not sugar in juice from tops.	Solids not sugar in butts.	Average solids not sugar in juice.	Tops by polarization.	Butts by polarization.	Average of polarization.	No. of analysis.
Sept. 17	Egyptian Corn		1.035	1.037	9.87	9.22	3.7	4.6	5.5	3.6	4.1	4.5	.67	1.02	.84				
Sept. 11	...do		1.064	1.063	14.68	15.07	2.9	2.6	7.6	7.9	2.7	7.7	4.18	4.57	.37				
Sept. 17	Fodder		1.025	1.030	7.93	5.27	4.4	1.8	1.4	1.5	3.1	1.4	2.13	1.97	2.05				
Sept. 11	Brown Doura			1.055							.8	3.7			12.51				88
Oct. 1	...do			1.056							2.7	3.7			4.88				160
Sept. 11	White Doura			1.084							1.9	8.7			7.00				
Oct. 1	...do			1.086															
Aug. 23	Corn	Two weeks before plucking ears	1.049	1.048			4.8	4.9	4.9	6.4	4.8	5.6							
Aug. 23	...do	At time of plucking ears	1.047	1.049			3.4	3.4	7.1	6.3	3.4	6.7							

LOUISIANA SUGAR CANES.

Date.	Variety.	Portion.	Number of stalks.	Total weight, in pounds.	Weight of leaf top, in pounds.	Weight of stripped cane, in pounds.	Weight of top, stripped, in pounds.	Total length to end of leaves, in feet.	Length of stripped cane.	Length of leaf top, stripped, in feet.	Diameter at butt, in feet.	Diameter at first leaf, in feet.	Number of joints in butt.	Number of joints in middle.	Length of first joint.	Length of second joint.	Length of middle joint.	Length of first leaf joint.	Per cent. of water in cane.	Weight of juice, in pounds.	Per cent. of juice.	Specific gravity of juice.	Per cent. of solids in juice.	Glucose, per cent. of, in juice.	Sucrose, per cent. of, in juice.	Per cent. of solids not sugar, in juice.	Polarization, per cent. sucrose.
Nov. 11	Ribbon-cane plant, 1879	Top ...	....	......	....	......	....	......	....	....	.....	.....	....	....	......	....	....	....	85.51	.668	....	1.036	7.36	4.08	1.57	.71	7.08
Nov. 11	....do	Middle.	....	......	....	......	....	......	....	....	.....	.....	....	....	......	....	....	....	79.19	2.919	....	1.056	13.62	1.98	11.30	.34	11.13
Nov. 11	....do	Butt...	2	13.23	2.68	10.55	1.07	13.12	6.72	1.34	.124	.118	8	10	.291	....	....	.262	80.11	3.025	....	1.063	15.28	.71	......	......	13.97
Nov. 11	....do	Top ...	....	......	....	......	....	......	....	....	.....	.....	....	....	......	....	....	....	84.90	.366	....	1.040	8.82	4.29	2.83	1.70	......
Nov. 11	....do	Middle.	....	......	....	......	....	......	....	....	.....	.....	....	....	......	....	....	....	78.18	1.464	....	1.057	13.79	1.61	11.30	.88	......
Nov. 11	....do	Butt...	1	6.00	1.19	4.81	.68	12.89	6.99	1.57	.124	.115	9	11	.239	....	.426	.220	76.19	1.486	....	......	......	.81	13.64	......	......
Nov. 11	....do	Top ...	....	......	....	......	....	......	....	....	.....	.....	....	....	......	....	....	....	81.81	.761	....	1.031	10.96	2.94	6.30	1.72	5.97
Nov. 11	Ribbon-cane plant, 1878	Middle.	....	......	....	......	....	......	....	....	.....	.....	....	....	......	....	....	....	91.99	2.381	....	1.087	16.31	.66	15.82	......	15.79
Nov. 11	....do	Butt...	2	10.26	2.63	7.63	1.35	11.81	5.81	1.57	{ .127 .124 }	.112	6	9	{ .164 .295	.246 .361	....	.262 .164 }	71.63	2.055	....	1.074	17.71	.45	17.17	.09	17.00
Nov. 11	Red cane, 1878	Top ...	....	......	....	......	....	......	....	....	.....	.....	....	....	......	....	....	....	81.97	.739	....	1.047	10.32	3.41	2.14	4.77	5.06
Nov. 11	....do	Middle.	....	......	....	......	....	......	....	....	.....	.....	....	....	......	....	....	....	75.67	2.795	....	1.064	15.59	1.41	13.36	.82	14.07
Nov. 11	....do	Butt...	2	11.65	2.30	9.35	1.30	11.48	6.47	1.71	{ .131 .115 }	.108	....	....	.203	....	....	.148	78.22	3.113	....	1,066	15.69	1.04	15.26	.39	14.59


Sucrose
Glucose
Chinese
Early Amber
Liberian
Honduras
Early Amber

For purpose of further comparison the following analyses of sugar canes and juice of the sugar-cane grown in Madras, India, are given below. The canes were divided into upper, middle, and lower thirds, each third being 2 feet in length, except the lower thirds of the selected canes, which were 3 feet in length.

	Bundle of medium good canes.			Bundle of selected canes.		
	Upper third.	Middle third.	Lower third.	Upper third.	Middle third.	Lower third.
Bagasse	7.630	8.470	8.300	7.580	8.650	8.290
Sucrose	10.630	13.310	13.370	9.490	13.640	13.850
Glucose	2.640	1.510	1.540	2.430	.736	.710
Ash	.307	.259	.233	.545	.363	.349
Water	78.334	75.612	76.122	79.484	75.628	75.945
Undetermined	.459	.839	.455	.471	.983	.856
	100.000	100.000	100.000	100.000	100.000	100.000

ANALYSIS OF EXPRESSED JUICE.

Sucrose	11.510	14.550	14.580	10.270	14.930	15.110
Glucose	2.860	1.650	1.680	2.630	.806	.775
Ash	.333	.283	.255	.590	.398	.381
Undetermined	.497	.917	.485	.510	1.076	.934
Water	84.800	82.600	83.000	86.000	82.790	82.800
	100.000	100.000	100.000	100.000	100.000	100.000

CHEM. CENT. BLATT., *February*, 1879.

For more clearly presenting the facts developed by the examinations of the four kinds of sorghum, the following chart represents graphically the foregoing results:

It will be observed how closely the Early Amber and Liberian correspond in their development, being almost identical, and yet being clearly distinct varieties. It will also be seen that while these two varieties attain a content of sugar in their juices equal to the average content in the juice of sugar-cane by the middle of August, the Chinese does not reach this condition until the last of September, while the Honduras does not reach this point until the middle of October.

It will be seen also that after having attained approximately the maximum content of sugar, this condition is maintained for a long period, affording ample time to work up the crop.

It is doubtless true that had the season been longer it would have been found that the Chinese and Honduras, having once attained this full development of sugar, would also have retained it; but, as is seen by the chart, the heavy frosts and subsequent warm weather which happened about November 24 caused a rapid diminution of sucrose in each variety, and a corresponding increase in glucose.

The converse of what is found true of the sucrose is clearly shown as to the development of the glucose, and it is seen that a minimum quantity once attained is continued a long time, and that this minimum is quite as low as the average amount found present in the sugar-canes.

It is obvious that the results depicted upon the chart are not to be taken as entirely exact, but the general fact represented is without doubt true, and with a still larger number of observations the approach to true curves would be found nearer than here represented.

The line representing the average per cent. of sucrose in sugar-beets

is from the results of analysis of thirteen specimens of sugar-beets grown upon the agricultural college farm, Amherst, Mass., and analyzed by Professor Goessmann (*vide* Mass. Agric. Rept., 1870–'71).

An average of all the examinations made of these four sorghums during these periods when they were suitable for cutting gives the following results:

Early Amber, from August 13 to October 29 inclusive, 15 analyses, extending over 78 days, 14.6 per cent. sucrose.

Liberian, from August 13 to October 29 inclusive, 13 analyses, extending over 78 days, 13.8 per cent. sucrose.

Chinese, from September 13 to October 29 inclusive, 7 analyses, extending over 46 days, 13.8 per cent. sucrose.

Honduras, from October 14 to October 29 inclusive, 3 analyses, extending over 16 days, 14.6 per cent. sucrose.

Besides the investigations above mentioned, there have been made 35 experiments in making sugar from corn-stalks, sorghums, pearl millet, &c., in all of which there have been used over 23 tons of stalks. The result of these experiments has been to fully confirm all the experiments not only of the previous year, but also to help towards the solution of certain questions of the highest practical importance. In every case it has been found that the quality of the sirup obtained has been precisely such as the previous analysis in the laboratory of the juice used made probable. An average of the nine best sirups obtained showed a percentage of cane-sugar present equal to 92.7 of the amount originally present in the juice, while an average of the nine poorest (*i. e.*, containing the lowest percentage of cane-sugar) showed a percentage of cane-sugar present equal to 90.1 of the amount present in the juice.

This must not be understood to mean that there has been no loss of sugar in the process of manufacture, as such conclusion would be quite erroneous, as will be seen by consulting tables further on in this report.

Below are given the detailed results of 33 experiments in the making of sirups from sorghum, pearl millet, and corn-stalks, and analyses of the juices from which these sirups were made. These stalks were obtained from neighboring farmers, and, as will be seen, were never in the condition best suited for working, but the results obtained from them are, however, of great practical value, and are given in detail.

The last column represents the relative loss of sucrose in making sirup, as compared with the glucose present, but gives no indication as to the absolute loss which may have been incurred, and since the economical production of sugar largely depends upon the amount of this loss, this matter is discussed more fully in another place.

Varieties.	Date of experiment.	Pounds of raw stalks.	Pounds of leaves and tops.	Pounds of tops.	Pounds of stripped stalks.	Pounds of topped stalks.	Pounds of juice expressed.	Specific gravity of juice.	Per cent. of juice in raw stalks.	Per cent. of juice to stripped stalk.	Per cent. of sucrose in juice.	Per cent. of glucose in juice.	Pounds of sirup obtained.	Per cent. of sirup in raw stalks.	Per cent. of sirup in juice.	Polarization of sirup.	Sucrose in sirup by analysis.	Glucose in sirup by analysis.	Per cent. of total solids in juice.	Per cent. of glucose in juice.	Per cent. of sucrose in juice.	Polarization of juice.	Relative loss of sucrose in making sirup.
Early Amber sorghum, topped but not stripped.	Sept. 18	1,603	......	234	......	1,369	684	1057	42.67	......	8.70	4.30	98.5	6.15	14.40	46.4	......	......	13.01	4.30	8.70	......	......
	Sept. 24	2,566	......	395	......	2,171	1,063	1060	41.43	......	11.10	3.10	151.0	6.00	11.49	48.0	51.1	29.6	......	3.10	11.10	11.43	14.9
	Sept. 30	2,436	......	329	......	2,107	975	1057	40.02	......	11.10	3.50	169.1	6.94	17.16	44.3	42.3	20.6	15.41	3.50	11.10	10.50	8.7
	Oct. 1	1,778	......	258	......	1,520	660	1061	37.12	......	11.60	3.70	102.8	5.78	15.67	51.2	56.6	25.2	15.35	3.70	11.60	10.50	6.6
	Oct. 21	891	......	131	......	760	382½	1068	42.93	......	11.91	2.63	58.0	6.51	15.17	58.3	62.9	15.7	......	2.63	11.91	......	4.8
Honduras sorghum, topped and stripped.	Oct. 9	556	88	....	468	......	229	1072	41.01	48.93	12.30	2.50	41.2	7.41	18.00	51.8	60.9	16.8	16.57	2.50	12.30	11.80	4.7
Honduras sorghum, topped but not stripped.	Oct. 25	281	......	10	......	271	113	1077	40.21	......	10.49	1.14	15.5	5.52	11.49	61.0	70.2	8.6	17.38	1.14	10.49	......	1.1
Honduras sorghum, topp'd and stripped.	Nov. 1	1,405	231	....	1,174	......	666	1058	47.40	56.73	9.24	3.63	97.5	6.94	14.65	37.2	36.4	31.7	13.63	3.63	9.24	......	18.4
	Nov. 3	1,231	117	....	1,114	......	611	1058	49.63	54.85	7.70	5.10	88.5	7.19	11.47	38.1	46.3	32.9	13.49	5.10	7.70	......	1.7
	Nov. 4	1,431	155	....	1,276	......	660	1054	46.12	51.72	5.40	5.40	86.8	6.07	13.16	30.4	39.3	36.1	12.18	5.40	5.40	......	......
	Nov. 6	3,368	385	....	2,983	......	1,608	1055	47.74	53.91	6.60	5.00	221.5	6.58	13.77	33.4	33.4	33.1	......	5.00	6.60	......	6.7
Chinese sorghum, topped and stripped.	Sept. 23	319	76	....	243	......	111	1066	34.80	45.68	11.30	2.80	17.3	5.43	15.60	57.4	57.9	16.4	......	2.80	11.30	......	2.2
Chinese sorghum, topped but not stripped.	Oct. 2	296	......	49	......	247	139	1060	46.96	......	11.60	2.30	20.0	6.76	14.39	46.3	54.4	18.3	16.46	2.30	11.60	8.90	8.7
	Oct. 11	1,679	......	187	......	1,492	542	1060	32.28	......	5.58	8.06	74.9	4.46	13.82	26.3	27.8	57.5	15.18	8.06	5.58	4.80	8.3
	Oct. 25	1,709	......	245	......	1,464	562	1058	32.88	......	5.01	4.89	77.7	4.55	13.82	36.0	35.8	39.1	......	4.89	5.01	......	2.8
Liberian sorghum, topped and stripped.	Aug. 28	......	......	....	......	......	20	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
	Nov. 7	2,544	454	...	2,090	......	1,009	1072	36.66	48.28	10.54	4.62	186.4	7.33	18.47	48.0	47.5	24.2	......	4.62	10.54	......	3.3
Pearl millet, topped and not stripped.	Oct. 2	378	......	31	......	347	106	1047	28.04	......	6.60	1.60	10.2	2.71	9.68	39.3	47.2	17.2	15.16	1.60	6.60	4.60	7.2
	Oct. 10	437	......	44	......	393	131	1047	30.00	......	6.36	1.49	12.4	2.84	9.48	41.4	46.8	12.7	10.03	1.49	6.36	3.50	2.3
Field corn, topped and stripped.	Sept. 29	222	67	...	155	......	70	1070	31.53	45.16	10.90	2.40	9.5	4.28	13.56	52.7	62.0	12.6	15.01	2.40	10.90	10.05	......
	Oct. 4	1,969	667	....	1,302	......	494	1035	25.09	37.94	5.40	2.30	46.0	2.34	9.31	26.9	48.1	23.9	9.43	2.30	5.40	4.06	3.3
	Oct. 7	1,519	493	....	1,026	......	384	1043	25.28	37.43	4.80	3.70	29.6	2.61	10.31	27.3	59.8	31.3	......	3.70	4.80	......	[illegible]
	Oct. 8	1,498	472	....	1,026	......	395	1040	26.37	38.50	5.10	3.80	40.5	2.71	10.26	21.4	34.5	36.1	18.79	3.80	5.10	......	8.6
	Oct. 13	......	......	....	1,095	......	332	1038	......	30.32	2.70	4.48	36.1	......	10.87	18.5	25.5	42.0	8.07	4.48	2.70	......	.0
Egyptian sugar-corn, topped and stripped.	Sept. 11	621	240	....	381	......	159	1063	25.60	41.73	8.25	2.85	[illegible]	4.89	19.08	52.9	......	......	......	2.85	8.25	......	......
Stowell's Evergreen corn, topped and stripped.	Oct. 16	3,435	1,035	....	2,400	......	1,123	1042	32.69	46.79	8.28	1.19	132.0	3.84	11.75	37.8	20.9	26.1	11.91	1.19	8.28	......	42.9
	Oct. 17	4,185	1,261	....	2,924	......	1,395	1042	33.33	47.71	7.35	1.25	157.3	3.76	11.27	11.5	18.8	41.6	11.24	1.25	7.35	5.10	51.4
	Oct. 18	1,968	593	....	1,375	......	612	1044	31.10	44.51	......	......	68.8	3.50	11.25	44.3	46.7	17.2	......	....	......	......	......
Miller's sweet corn, topp'd and stripped.	Sept. 17	760	281	...	479	......	214	1042	28.16	44.68	5.20	3.80	24.2	3.21	11.39	38.1	45.3	31.2	......	3.80	5.20	......	.9
	Sept. 18	1,407	527	....	880	......	415	1051	31.63	50.57	7.40	4.20	57.6	4.09	12.94	38.1	45.3	31.2	16.21	4.20	7.40	......	4.6
	Sept. 19	1,191	441	...	750	......	254	1051	21.33	33.87	7.90	4.50	48.8	4.10	19.23	38.1	45.3	31.2	......	4.50	7.90	......	4.5
Miller's sweet corn, topp'd and not stripped.	Sept. 20	821	......	111	......	710	268	1048	32.64	......	......	......	31.9	3.88	11.88	38.1	45.3	31.2	......	...	......	......	......
	Sept. 25	1,001	......	154	......	847	294	1017	29.40	......	6.50	3.70	33.0	3.31	11.24	38.7	41.9	30.9	9.39	3.70	6.50	......	4.5

The apparatus used in the experiments, besides a few barrels and pails for holding the juice, consisted of a copper tank of the following dimensions: 4 feet 3 inches long, 2 feet 3 inches deep, 2 feet 3 inches wide; a galvanized iron pan 9 feet long, 8 inches deep, 3 feet 6 inches wide. This iron pan was surrounded by a wooden frame of 2-inch plank so as to support the sides, and each pan was placed in brickwork with chimney, and so arranged as to permit a fire to be kept below it in direct contact with the bottom. In the case of the copper tank the flames played about the sides also, so as to heat the contents more rapidly. The galvanized iron pan was such as could readily be constructed by any ordinary tinsmith or mechanic. The copper tank was used for defecation with lime; the galvanized iron pan for evaporation. The process, in brief, is as follows: After topping and stripping the corn or sorghum, it was passed through the mill, and when sufficient juice had been obtained it was heated in the copper tank to a temperature of 82° C.=180° F. After the juice had reached this temperature, there was added to it, with stirring, cream of lime, until a piece of litmus paper dipped in the juice showed a purple or bluish-purple color. The heat was now raised to the boiling point, and, so soon as the juice was in good ebulition, the fire was drawn and a thick scum removed from the surface of the juice. After a few minutes the sediment from the juice subsided, and by means of a siphon the clear liquid was decanted off, leaving a muddy sediment which was equal to about one-tenth to one-twentieth of the bulk of the juice. It was found that by means of the stop-cock at the bottom of the defecator, it was possible to draw off the clarified juice more thoroughly than by means of the siphon, so that this method has been adopted for removing the juice. It is only necessary to collect in a separate vessel the first portions of juice coming from the stop-cock, which are turbid, and passing these through the bag filter with the sediment. This muddy sediment was then drawn off by means of a stop-cock and filtered through a plaited-bag filter, and the clear filtrate therefrom was added to the liquid previously siphoned off. The clarified juice, which, during the above operation, is not allowed to cool below a temperature of 66° C. or 150° F., was now emptied into the evaporating pan, and there was added to it, with stirring, a solution of sulphurous acid in water until the lime present was neutralized, as was shown by the reddening of litmus paper when it was dipped in the juice. The evaporation was now hastened as much as possible, and the juice concentrated to a sirup at a boiling point of 112° C., equal to 234° F. or thereabouts. During the close of the evaporation there is great danger of scorching the sirup, and this was obviated by allowing only coals beneath the evaporator and briskly stirring the sirup by means of paddles 8 or 10 inches wide. When the sirup reached the density above indicated it was drawn off into wooden tubs, the fire having previously been drawn from beneath the evaporator.

It is doubtless true that many failures result in securing a crystallizable sirup even from good juice, owing to the operations of pressing of the cane, defecation, and evaporation being too much protracted. In order that those wishing to enter upon this industry may know what is practically attainable, even with common appliances, the following data are given:

In experiment No. 3, 2,107 pounds of topped stalks of Early Amber cane were pressed by the mill in 3½ hours, yielding 975 pounds of juice. The time required for heating the juice, defecation with lime, and evaporation to sirup was 5¾ hours. In order that the inferior character of the material supplied for these experiments might be known, speci-

mens were taken from the several lots of stalks in experiments Nos. 1, 2, 3, 4, and it was found that the average weight of the stalks in these lots was four ounces each.

In most of the experiments above recorded the juice was raised to the temperature of 82° C. (180° F.), and then neutralized with milk of lime, but several experiments were made to learn the effect produced by neutralization with lime at different temperatures.

In experiment No. 4 the juice was divided into two portions, and the lime was added to the one portion at 40° C. (104° F.), to the other portion at 25° C. (77° F.); and the portions were separately evaporated to sirup.

In experiment No. 13 the lime was added directly after the juice was obtained from the mill, the temperature being 16° C. (61° F.).

In experiment No. 18, the lime was added at 80° C. (176° F.).

In the above-mentioned experiments the results were entirely satisfactory, and seem to indicate that the neutralization by means of lime may be effected at any stage below 82° C. No experiments were made in neutralizing at higher temperature than 82° C.

An experiment was also made to determine whether splitting the canes before they were passed through the mill would increase the percentage of juice obtained from the stalks. One hundred pounds of butt ends of Honduras sorghum were split lengthwise and then passed through the mill. Another parcel of one hundred pounds of butts of the same variety of sorghum, equal in all respects to the previous lot, was passed through the mill without splitting them. The results obtained were as follows: Percentage of juice obtained from split stalks, 54 per cent.; percentage of juice obtained from unsplit stalks, 57 per cent.; from which it would appear that in this case at least, the previous splitting of the stalks occasioned an appreciable loss in juice.

In plate 27 the apparatus used in these experiments is figured, showing the relative position of mill, pans, &c.

Two pans only are represented as being in use, viz., the defecating pan upon the left hand in the wood-cut and the evaporator upon the right hand. The stop-cocks by which the contents of the defecating pan are removed is not shown in the plate, being concealed by the small evaporator in front. A space of about two feet separates the brick work underneath the several pans, permitting one to pass easily about them.

The apparatus represented in the rear is used for making sulphurous-acid solution, and consists of a small-sized hot-water tank for kitchen-range, about 40 inches long and 10 inches diameter. Into this powdered charcoal and oil of vitriol are put, and the sulphurous gas is passed through iron pipes into a wash-bottle containing oil of vitriol, and from thence into a barrel nearly filled with water. A safety tube is connected with the wash-bottle to prevent any possible rushing back of the water into the generator in case of the withdrawal of the heat. By this apparatus a barrel or two of the solution may be made in a short time and at an expense not over 75 cents per barrel. For two barrels there would be required 75 pounds of oil of vitriol and 7 pounds of powdered charcoal.

A few of the experiments made give a reasonable basis for estimating the probable yield of sirup and sugar to the acre; and, therefore, an approximate estimate of the cost of producing sugar.

Below is a tabulated result of a few of the experiments from stalks grown upon the grounds of the department. These stalks were grown in rows 3 feet apart and in drills, and although a good crop, there is no

doubt but that upon good land the estimated yield to the acre could be obtained:

Varieties.	Pounds stalks per acre.	Sirup obtained.	Sirup, juice at best.	Sirup, juice = 70 per cent.
Chinese sorghum	38, 600	2, 096	2, 397	3, 673
Liberian sorghum	33, 727	2, 472	2, 609	3, 783
Early Amber sorghum	32, 415	2, 100	2, 615	3, 661
Honduras sorghum	66, 151	3, 652	5, 168	7, 537
Pearl millet	65, 000	1, 846	3, 128	4, 865
Field corn	27, 240	1, 166	....	1, 807

The first and second columns give the results actually secured, but the several juices were not in their best condition as compared with the results given in the first table. The third column is the amount of sirup the same weight of stalks would have yielded had they been cut at the proper time. The juice obtained from the stalks by the imperfect means at command of the department was little more than half the amount present in the stalks.

The fourth column represents the results attainable by the use of a mill that would give 70 per cent. of juice from the stalks; a result which is possible, and which is claimed by manufacturers of mills.

There is no doubt but that, when the present industry shall have secured the employment of the capital and scientific ability which has developed the beet-sugar industry, even these results, which may appear extravagant to many, will be assured.

Although, as has been stated, these sirups were obtained from stalks in which the maximum content of sugar had not yet been developed, they did, however, all crystallize well, and all yielded excellent sugar.

At the present the sugar hasbeen separated from the Chinese sorghum sirup only, which yielded in the first crop of crystals 54.7 per cent. of its weight in sugar; the Early Amber sirup, which yielded 47.5 per cent. of sugar; and from the field-corn sirup, which yielded 39.3 per cent. of sugar. This latter experiment is worthy of especial mention, since the result secured is not only most surprising, but contrary to an almost universal belief. The corn-stalks used were of three varieties: Lindsay's Horse Tooth, Improved Prolific, and White Dent—three coarse-growing white field corns. The stalks grew in drills 3 feet apart, and about 9 or 10 inches apart in the drill. The ears were plucked after they had thoroughly ripened, and the husks were dead and dry. The corn was plump and sound, and yielded at the rate of 69.1 bushels of shelled corn (56 pounds to the bushel) to the acre. The stalks were then topped, stripped, and crushed, and the juice proved to be the best juice yet obtained from corn-stalks, at any period of growth or of any variety.

Below are given the results of the examination of the stalks of Egyptian sugar-corn, Honduras and Early Amber sorghums, and the leaves from the same. This examination was made for the purpose of determining the loss of sugar in the method employed in its extraction, also to determine the relative nutritive value of the leaves and stalks, pressed and unpressed. The stalks selected were split lengthwise, so that a fair average might be taken, and one half was dried thoroughly without pressing, and the other half was passed through the mill, and the bagasse, or pressed stalks, carefully saved and dried.

Leaves, stalks, and bagasse from corn and sorghums.

Varieties.	Weight fresh.	Weight bagasse.	Weight juice.	Per cent. juice.	Weight dry.	Per cent. water.
Egyptian sugar-corn, leaves	380	......	......	....	116.6	67.3
Egyptian sugar-corn, one-half of 4 stripped stalks, unpressed	832	......	......	....	126.0	84.9
Egyptian sugar-corn, one-half of 4 stripped stalks, pressed	875	460	415	47.43	99.0	88.7
Honduras sorghum, leaves	432	......	......	....	100.8	76.7
Honduras sorghum, one-half of 2 stripped stalks, unpressed	1,428	......	......	....	285.3	80.0
Honduras sorghum, one-half of 2 stripped stalks, pressed	1,390	724	666	47.91	222.7	84.0
Early Amber sorghum, leaves	399	......	......	....	99.7	75.0
Early Amber sorghum, one-half of 3 stripped stalks, unpressed	651	......	......	....	157.9	75.7
Early Amber sorghum, one-half of 3 stripped stalks, pressed	905	458	447	49.39	147.8	83.7

A determination of the proximate constituents of the dried leaves, stalks, and bagasse is given below, from which it will appear that there still remains a large amount of sugar in the bagasse which the process employed failed to remove from the cane or stalks, also that the per cent. of starch compounds is greater in the pressed than in the unpressed stalks, and that the percentage of nitrogenous matter remains nearly the same. Since the nutritive value of the pressed stalks is nearly if not quite equal to that of the unpressed stalks, weight for weight, and as they are left in a mechanical condition suitable for their preservation as green fodder by the system of ensilage, it would appear desirable that experiments be made leading to their utilization for this purpose.

Proximate analyses of stalks, bagasse, and leaves of sweet corn and sorghum, calculated to the dry substance.

Varities.	Unpressed stalks, Early Amber sorghum.	Unpressed stalks, Honduras sorghum.	Unpressed stalks, Egyptian sugar-corn.	Bagasse of Early Amber sorghum.	Bagasse of Honduras sorghum.	Bagasse of Egyptian sugar-corn.	Leaves of Early Amber sorghum.	Leaves of Honduras sorghum.	Leaves of Egyptian sugar-corn.
Organic acid, chlorophyl, color	7.36	5.39	2.85	1.47	2.01	1.11	1.46	3.29	1.48
Wax	.94	.33	.44	.35	.84	.40	5.05	1.67	.54
Brown resin	6.98	6.00	8.11	5.11	3.53	5.75	7.91	6.67	5.20
Sugars	34.73	38.14	26.01	19.36	21.77	10.08	8.58	9.37	8.21
Gum	2.14	1.57	1.38	2.04	2.20	1.33	3.82	2.78	4.54
Starch isomers	20.34	17.67	22.44	31.46	26.27	23.16	14.49	21.22	24.77
Albuminoids	4.95	4.81	6.90	3.96	3.87	6.04	13.14	10.43	11.34
Alkali extract, by difference	....	5.15	6.09	13.35	15.10	22.26	12.08	11.98	12.65
Crude fiber	16.01	16.48	19.82	19.10	20.66	25.00	17.98	18.51	20.83
Ash, by ignition	6.55	4.46	5.96	3.80	3.75	4.87	15.49	14.08	10.44
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

By reference to the two preceding tables, it will be seen that a very large percentage of the sugar was lost by the method employed in its production.

The amount of sugar in the Early Amber cane, dry, is to the amount present in the Early Amber bagasse, dry, as 100 is to 55.74.

In Honduras cane, dry : Honduras bagasse, dry : : 100 : 57.08.

In Egyptian sugar-corn, dry : Egyptian sugar-corn bagasse, dry : : 100 : 38.75

As will be seen from these analyses—

	Per cent.
The Honduras cane, fresh, contained sugar	7.62
Early Amber cane, fresh, contained sugar	8.42
The Egyptian sugar-corn, fresh, contained sugar	3.94

While the sugar remaining in the bagasse, calculated to the fresh cane which produced these bagasses, gave as follows:

	Per cent.
Honduras sorghum, sugar	3.49
Early Amber sorghum, sugar	3.16
Egyptian sugar-corn, sugar	1.14

In other words, it will appear that there was occasioned a loss of—

46.4 per cent. of the sugar present in Honduras sorghum.

37.4 per cent. of the sugar present in Early Amber sorghum.

28.9 per cent. of the sugar present in Egyptian sugar-corn.

The importance, therefore, of a good mill cannot be overestimated, and it is desirable that efforts be made to devise some process by which results approximating those obtained in the extraction of sugar from beets shall be attained, since it is obvious that, should the beet-sugar industry be conducted in so wasteful a manner as is the production of sugar from cane or from sorghum, this important industry could not survive a year, even in those countries most favorably circumstanced in regard to the production of beet sugar.

For convenience the following results, which were obtained last year, are appended, since these experiments were only confirmed this year, but the results have not been tabulated.

In the experiments made with corn-stalks the stalks were invariably stripped, the tops being cut off at about the second joint. The percentage of stripped stalks, leaves, and tops is given in this table:

Corn-stalks.	Per cent. of stripped stalks.	Per cent. of leaves and tops.
No. 1	67.57	32.43
No. 2	58.69	31.31
Nos. 3 and 4	67.46	32.54
Average	67.91	32.09

In those cases where the sorghum was stripped and topped the following percentage of stripped stalks and of leaves and tops was obtained:

Sorghum.	Per cent. of stripped stalks.	Per cent. of leaves and tops.
No. 5	72.67	27.33
No. 6	72.55	27.45
Average	72.61	27.39

On account of the trouble in stripping the stalks, experiments were made with stalks unstripped, the tops alone being removed, and these

experiments appear to prove that this troublesome operation of stripping may be avoided without any diminution of the amount of juice or of sugar obtained therefrom.

Below are the results obtained from stripped and unstripped sorghum, calculated to the raw stalks used.

By raw stalks is meant the stalks as they were cut in the field—leaves, tops, and all.

Sorghum.	Average per cent. of juice to raw stalks.	Average per cent. sirup in juice.
Stripped sorghum, two experiments	35.02	15.00
Unstripped sorghum, five experiments	40.60	15.47

From the above it will be seen that not only was an increased amount of juice obtained, but that this juice gave an increased percentage of sirup, and there appears nothing unusual in the treatment of this juice from the unstripped cane, nor was there any appreciable difference in the readiness of the sirup to crystallize, nor in the character of the sugar finally obtained.

Although perhaps further experiments are desirable before considering this point as settled, it would appear from the above that not only was stripping unnecessary, but that it really involved a loss in the amount of sugar to be obtained; at least the above results indicate a difference of twenty per cent. increase in product in favor of the unstripped cane. It is not improbable that the above result is due to the fact that the leaves in passing through the mill tended to fill up the interstices between the compressed cane, and thus prevented the expressed juice from flowing through between the rolls with the bagasse. In case of discoloration by action of moisture or other causes, it will, however, be advisable, and probably necessary, to strip the stalks.

Several experiments were also made with both corn-stalks and sorghum to determine the relative value of the upper and lower half of the stalks, with the results given in the following table:

Corn and sorghum.	Percentage of juice to stalks.	Specific gravity of juice.	Percentage of sirup in juice.
Corn-stalks, butt ends, No. 3	29.04	1053	14.62
Corn-stalks, top ends, No. 4	19.94	1050	13.46
Sorghum, butt ends, No. 8	47.49	1059	16.41
Sorghum, butt ends, No. 10	41.49	1062	16.47
Sorghum, top ends, No. 9	43.16	1057	14.70
Sorghum, top ends, No. 11	34.09	1059	14.26

Nos. 8 and 9 were the butts and tops of the same stalks, and were cut just after a rain, as were also Nos. 10 and 11, from which the rain had evaporated, and the difference in yield of juice and sirup between butts and tops is nearly constant. The increase in specific gravity of the juice from butts over that from the top is also worthy of notice.

From the above table the conclusion from the average results is that the proportion, by weight, of sugar in the lower half of the stalk is to the sugar in the upper half as follows: Corn butts to corn tops as 159 to 100; sorghum butts to sorghum tops as 131 is to 100. As will be seen by reference to the first table, the stalks of both corn and sorghum in the above experiment were divided almost equally by weight into

butts and tops, so that the above proportion fairly represents the proportion of yield of sugar in the upper and lower half of the cane. There was a marked difference in the appearance of the juice as it flowed from the mill (that from the butts being lighter in color, especially in the experiments with corn), but after clarification no appreciable difference could be observed, nor was there any difference in the product except the quantitative one above mentioned, which was, however, a marked difference. Also, there was a marked difference in granulation in favor of the juice from the butts.

The experiments of this year (1879) doubtless explain some of the results of the previous year; since it is probably true that, owing to immaturity, the tops had not yet attained their maximum content of sugar. A study of the previous tables giving results of the analyses of sorghums shows that up to a certain period the lower half of the cane is the best, but that this does not remain true of the sorghum, as it does of the sugar-cane in Louisiana, since the sorghum does have time to completely mature, which is not true of the sugar-cane in our country.

In the following table there have been calculated from the results given of the experiments in the making of sugar the following:

1st. The percentages of the sugar present in the juices operated upon, which were obtained in the sirup.

2d. The percentage of crystallizable sugar (sucrose) present in the juices, which was obtained in the sirup.

3d. The percentage of uncrystallizable sugar (glucose) present in the juices, which was obtained in the sirup.

4th. The percentage of crystallizable sugar present in the juices, which was inverted by the process of manufacture.

5th. The percentage of uncrystallizable sugar (glucose) destroyed during the process of manufacture.

The presence of the same relative proportions of crystallizable and uncrystallizable sugar in a sirup to those present in the juice from which this sirup has been prepared, by no means implies that there has been no inversion of the crystallizable sugar; for the destructive action of an excess of lime upon glucose is well known and is not unfrequently made available in the production of sugar. Hence it not unfrequently happens that the relative quantity of crystallizable sugar in the sirup may be greatly in excess of that present in the juice, even after a large quantity of the crystallizable sugar has been destroyed by inversion. It is only possible then to determine the character of the changes which have taken place in the sugars during the process of manufacture, by quantitatively determining the amounts of sucrose and glucose in the juices and in the sirups prepared from them.

Since, obviously, this is a question of the greatest practical importance, as bearing upon the profitableness of the production of sugar from corn-stalks or sorghum, the tables following will be studied with interest by those engaged in this production.

As will have been observed in the previous table, there is a constant but not uniform discrepancy between the polarization of the sirups and the amount of crystallizable sugar found present by analysis.

Almost invariably the amount of sucrose found present is somewhat in excess of the amount indicated by the polariscope, and this variation is such as to forbid any supposition that it is the result of error in observation or analytical work.

This explanation may be found by consulting the following tables, by which it appears that, although there is generally about the same amount of glucose in the sirups relative to the amount present in the juice

(averaging 97.1 per cent.), there is still evidence of the destruction of an average of 35 per cent. of the glucose. This destruction of glucose appears to be compensated, in part, by the inversion of a certain portion of the crystallizable sugar, and this inverted sugar possesses such action upon the polarized ray as to render the results of the polariscope practically worthless.

Practically, it appears that the proportion of crystallizable sugar present in the juice, which may be obtained in the sirup, depends greatly upon the condition of the stalks when worked. For, as will be seen, the average amount secured in all these experiments was but 77.1 per cent.; still in those sirups prepared from canes which were in the proper condition the amount was over 90 per cent. of the crystallizable sugar present in the juice operated upon. (See experiments Nos. 6 and 7.) It is not improbable that even better results may be secured after further experiments shall have perfected the process of manufacture; but in view of the fact that such results have been attained with such crude and simple apparatus as that employed in the experiments here recorded, this result is highly gratifying.

We may hope then to secure in sirup 90 per cent. of the crystallizable sugar present in the juice operated upon.

Number.	Per cent. of sugars in sirup of amount present in juice.	Per cent. of sucrose in sirup of amount present in juice.	Per cent. of glucose in sirup of amount present in juice.	Per cent. of sucrose inverted of amount present in juice.	Per cent. of glucose destroyed in process of making.
1					
2	82.3	66.7	138.3	33.3	0.0
3	74.7	66.1	102.1	33.9	31.8
4	83.3	76.0	106.0	24.0	18.0
5	85.1	80.2	107.8	19.8	12.0
6	94.4	89.1	120.9	10.9	
7	92.9	91.7	103.6	8.3	4.7
8	77.4	57.7	127.7	42.3	14.6
9	89.5	87.1	96.5	12.9	16.4
10	91.8	95.7	90.7	4.3	13.6
11	79.0	69.7	91.2	30.3	39.1
12	82.1	79.8	91.3	20.2	28.9
13	80.4	67.5	114.5	32.5	18.0
14	86.4	68.9	98.6	31.1	32.5
15	95.6	98.7	110.6	1.3	
16					
17	87.4	83.3	96.7	16.7	20.0
18	75.5	68.8	103.5	31.2	27.7
19	71.8	69.7	80.4	30.3	49.9
20	76.1	77.2	71.3	22.8	51.5
21	87.2	82.9	96.8	17.1	20.3
22	86.3	85.6	87.2	14.4	27.2
23	90.8	69.3	98.3	30.7	32.4
24					
25	102.2	102.7	102.0		
26	58.3	29.7	25.8	70.3	144.5
27	79.2	28.8	37.5	71.2	133.7
28					
29	96.1	98.5	92.8	1.5	8.7
30	85.4	79.2	96.1	20.8	24.7
31	118.5	110.1	133.2		
32					
33	84.9	77.5	93.7	22.5	28.8
Average	85.5	77.1	97.0	24.2	34.7

The results obtained in the experiments made with stalks from Stowell's Evergreen Sweet Corn are most remarkable and demand explanation. It will be seen that the juice obtained from these stalks

gave in the laboratory excellent results, and promised a sirup of fine quality. By reference to the tables it will be seen, however, that these sirups (see experiments Nos. 26 and 27) were wholly abnormal and very disappointing. These stalks were cut in Frederick, Md., October 11, packed in a close car, and, through an oversight, allowed so to remain during oppressively hot weather until the 15th. They were worked up on the 16th, 17th, and 18th. Upon their arrival at Washington they were found so heated as to render their removal from the car even difficult, and yet, as will be seen, the juice expressed from them appeared of excellent quality, but every attempt to produce from it a crystallizable sirup failed, and an analysis of the sirup showed that a very large percentage of the sugar had been inverted (in experiments Nos. 26 and 27), and that the destruction of glucose in the sirup had been unusually large, while the amount of crystallizable sugar present in the juice, and recovered in the sirup, was less than 30 per cent.

A few of the results attained appear to be only explicable upon the supposition that there have been slight errors in analysis, but revision of the work fails to reveal such errors, and the results are given in full without omission, hoping that future investigation may enable us to solve difficulties which at present appear irreconcilable.

Comparison of the upper and lower halves of sorghum-canes.

	Per cent.
Average per cent. of water in 17 specimens of Chinese sorghum……tops..	73. 05
Average per cent. of water in 16 specimens of Chinese sorghum……butts..	74. 46
Average per cent. of water in 20 specimens of Honduras sorghum……tops..	72. 57
Average per cent. of water in 20 specimens of Honduras sorghum……butts..	76. 15
Average per cent. of water in 23 specimens of Liberian sorghum……tops..	71. 67
Average per cent. of water in 23 specimens of Liberian sorghum……butts..	75. 22
Average per cent. of water in 22 specimens of Early Amber sorghum……tops..	72. 73
Average per cent. of water in 22 specimens of Early Amber sorghum.butts..	72. 13
Average per cent. of juice from 10 specimens of Chinese sorghum……tops..	45. 17
Average per cent. of juice from 10 specimens of Chinese sorghum……butts..	49. 80
Average per cent. of juice from 16 specimens of Honduras sorghum..tops..	42. 83
Average per cent. of juice from 17 specimens of Honduras sorghum.butts..	45. 44
Average per cent. of juice from 13 specimens of Liberian sorghum……tops..	42. 63
Average per cent. of juice from 13 specimens of Liberian sorghum……butts..	44. 50
Average per cent. of juice from 11 specimens of Early Amber sorghum..tops..	46. 68
Average per cent. of juice from 11 specimens of Early Amber sorghum.butts..	50. 58
Average specific gravity of juice from 17 specimens of Chinese sorghum, tops……	1. 0725
Average specific gravity of juice from 17 specimens of Chinese sorghum, butts……	1. 0708
Average specific gravity of juice from 21 specimens of Honduras sorghum, tops……	1. 0602
Average specific gravity of juice from 21 specimens of Honduras sorghum, butts……	1. 0584
Average specific gravity of juice from 24 specimens of Liberian sorghum, tops……	1. 0753
Average specific gravity of juice from 24 specimens of Liberian sorghum, butts……	1. 0730
Average specific gravity of juice from 22 specimens of Early Amber sorghum, tops……	1. 0765
Average specific gravity of juice from 22 specimens of Early Amber sorghum, butts……	1. 0771
Average per cent. of solid matter in juice from 16 specimens of Chinese sorghum……tops..	16. 21
Average per cent. of solid matter in juice from 17 specimens of Chinese sorghum……butts..	16. 81
Average per cent. of solid matter in juice from 19 specimens of Honduras sorghum……tops..	13. 85
Average per cent. of solid matter in juice from 20 specimens of Honduras sorghum……butts..	13. 92

	Per cent.
Average per cent. of solid matter in juice from 23 specimens of Liberian sorghum .... tops..	16.91
Average per cent. of solid matter in juice from 22 specimens of Liberian sorghum .... butts..	16.71
Average per cent. of solid matter in juice from 19 specimens of Early Amber sorghum .... tops..	17.59
Average per cent. of solid matter in juice from 21 specimens of Early Amber sorghum .... butts..	16.75
Average per cent. of water in tops, 79 specimens	72.45
Average per cent. of water in butts, 79 specimens	74.51
Average per cent. of juice from tops, 50 specimens	43.96
Average per cent. of juice from butts, 51 specimens	46.90
Average per cent. of solids in juice from tops, 77 specimens	16.18
Average per cent. of solids in juice from butts, 80 specimens	16.02
Average specific gravity of juice from tops, 84 specimens	10.71
Average specific gravity of juice from butts, 84 specimens	10.70

From the above comparison it will appear that there exists no marked difference in the amount of juice present in the upper and lower halves of the canes, nor in the quality of this juice as indicated by either the relative specific gravities or the total amount of solid matter present in the juices.

But by reference to the previous tables, giving the results in detail, the fact will appear in the case of each of the sorghums examined that, during the early stages of development of these plants, the total sugars present in the juices is comparatively low, often not one-third of the maximum afterwards found in the plant, and consequently the amount of sirup possible to be made from this immature cane is proportionately less than that which the same stalks would yield when fully matured.

It will also appear that, during this early and immature state of the plant, the relative amount of crystallizable surgar (sucrose) as compared with the total sugars present is much greater in the lower half of the canes. This condition remains, apparently, until the seed has reached the milky state, at which time the juices in both parts of the plant appear to be of equal value. But it must not be understood that the maximum content of sugar in the plant has been reached at this period of development, since, as will be seen by the tables, this is far from the fact.

From this period in the plant's development until the perfect ripening of the seed, the juices appear to uniformly increase in their content of crystallizable sugar, and to decrease in their content of uncrystallizable sugar.

Still later in the history of the plant there appears a slight deterioration in the quality of the juice from the lower half of the stalk, and it is found generally to be somewhat inferior to the juice from the upper half.

It appears probable that this deterioration of the juice from the lower part of the cane marks the incipient stages of death and the ultimate decay of the plant, the roots and leaves failing in their office to supply the full amount of nourishment which the plant requires. It begins to feed upon itself, so to speak, and it is to be observed that at this period the off-shoots from the upper joints of the stalk begin a vigorous growth and appear to live as parasites upon the parent stalk.

It will appear also that at the first examinations the specific gravity of the juices from the lower half of the cane is almost invariably greater than that of the juices from the upper halves, and that an equality of specific gravity appears to indicate an equality between the juices in their content of sugar not only, but in its relative proportions of sucrose and glucose.

Proximate analyses have been made of the seed of two varieties of sorghum, the Early Amber and the Chinese, the results of which are given below. It will be seen that this seed differs but little in composition from the other cereals, and closely resembles corn, and it will doubtless prove valuable as food for farm stock.

Constituents.	Sorghum seeds.	
	Early Amber.	Chinese.
Moisture	10.57	9.93
Ash	1.81	1.47
Fat	4.60	3.95
Sugars	1.91	2.70
Albumen, insoluble in alcohol	2.64	2.64
Albumen, soluble in alcohol	7.34	6.90
Gum	1.10	72
Starch, color, &c	68.55	70.17
Crude fiber	1.48	1.52
	100.00	100.00

Moisture was estimated from loss by drying at 105° C. Ash, by simple ignition; total albuminoids from total nitrogen multiplied by 6.25. Under "sugars" is given that portion of the 80 per cent. alcohol extract which was found soluble in water. The insoluble portion of this alcohol extract included a little red coloring matter, but otherwise seemed to be identical with the "zein" of maize. Gum was extracted by water, after use of ether and alcohol. Fat was extracted directly from the sample by absolute ether; it was yellowish, semi-solid, and very much resembled the fat similarly extracted from corn. Starch, color, &c., were determined by difference. In early amber there was found 64.05 per cent. and in Chinese sorghum 64.74 per cent. of starch by titration, with Fehling's solution of an acid extract made after extraction with ether, alcohol, and water.

Crude fiber is that portion, ash free, which still remains insoluble after treatment of the sample with ether, alcohol, water, dilute hydrochloric acid, and dilute potassic hydrate. It is usually white or slightly gray, and free from nitrogen.

Proximate analyses have also been made of the scum and sediment obtained in defecating the juice, with a view of throwing light upon the chemical character of this important process.

The result of these analyses are given below.

Constituents.	Liberian lime precipitate.	Honduras lime precipitate.	Honduras skimmings.
Moisture	9.77	7.69	5.72
Ash	21.69	7.00	14.30
Chlorophyll and wax	17.60	8.95	14.44
Sugars	10.80	43.96	15.06
Resins and trace albumen	−3.61	3.26	5.08
Gum	6.02	11.40	11.10
Albuminoids	22.58	4.55	8.05
Humus-like substances, diff	−5.73	12.71	5.58
Crude fiber	2.20	.48	5.49
Starch isomers	Trace.	Trace.	15.18
	100.00	100.00	100.00

The large amount of ash in Liberian lime precipitate and Honduras skimmings was due to the presence of considerable clay, which had been

used to hasten the clarification of the juice. There was little or no clay present in Honduras lime precipitate. The claying seems mechanically to have carried down a large proportion of the albumen in the Liberian lime precipitate.

The very great difference in these waste products is probably due almost wholly to differences in the manipulation of the juices.

Very probably there exists in lime precipitates a combined organic acid; this will be investigated in the future.

Whoever may detect error in the methods employed, or in the results stated, will confer a favor by mentioning the same.

It is certainly most desirable that these experiments be continued upon a larger scale, and with at least a dozen varieties of sorghum and an equal number of varieties of sweet, yellow, and white corn.

At least an acre of each variety should be grown, and the development of each should be watched through the season, and when the proper time for working up the crop has come, let the acre be worked up for sugar. Such an experiment would require little outlay and be productive of invaluable results. It would require at least three or four assistants additional in the chemical laboratory to attend to the continued analyses of the canes, and would necessitate a somewhat larger apparatus for working up the crop.

The correspondence addressed to this division upon this subject of sugar has steadily increased until it requires nearly all the time of one assistant to attend to it.

THE PERMANGANATE PROCESS FOR THE ESTIMATION OF SUGARS IN JUICES.

1. *Preparation of the juice.*

Usually two stalks were selected for analysis. Their maturity, as shown by the development of blossoms, seeds, and the color and condition of the glumes, was recorded. Then were noted—

a. The weight of the unstripped stalks.

b. The weight of the stripped and topped stalks, and, by difference, the weight of leaves and tops.

c. The average length and diameter of the stripped stalks.

These stripped stalks were then divided so that tops and butts were of equal weight. Then was found—

d. The average length each of tops and butts. The tops and butts were then separately analyzed. Each by itself was cut finely with a hatchet, and then bruised in an iron mortar. The bruised mass was then placed in a small bag, and submitted to a heavy pressure in an ordinary iron press.

The expressed juice was collected and weighed, and the percentage calculated to the unstripped stalks taken.

The juice thus obtained usually was greenish from the presence of chlorophyll. As the plant matured, the color of the juice inclined to amber, and in perfectly ripe stalks (especially of the Early Amber variety) the color was red, from the presence, in the central portion of the stalk, of a red coloring matter sparingly soluble in ether, readily dissolved by 80 per cent. alcohol.

The specific gravity of the juice was determined usually by a piknometer. It was found that the readings given by an accurate hydrometer accorded well with the specific gravity indicated by weight, if the

juice was previously allowed to stand for about half an hour, to allow included air to escape.

A weighed portion of the juice was dried, at a heat not exceeding 100° C., until two successive weights showed but little variation; the percentage of residue thus found was stated as *total solids in juice*. These figures can be regarded only as fair approximations, for chemists are well aware of the difficulties attending the perfect desiccation of saccharine juices. In this connection, however, the results are valuable as checks upon the sugar determinations.

For determination of sugars in the juice 100 c. c. were taken, and made in every case to 125 c. c. by addition of solution of subacetate of lead and water. Among other substances precipitated by the treatment were chlorophyll, albumenoid matter, gum, and lead salts of the inorganic acids of the ash.

The liquid was filtered perfectly clear through dry paper, and was sometimes colorless and sometimes amber. Every 10 c. c. of this liquid represented 8 c. c. of the original juice.

For the determination of glucose, 10 c. c. of this filtered liquor were taken, and for sucrose 5 c. c.

The portion for glucose was treated with considerable excess of Fehling's solution, and carefully heated on the water-bath, a thermometer being inserted in the liquid, which was not allowed to rise above 75° C. At this temperature perfectly pure sucrose does not reduce Fehling's solution in the least.

The portion for sucrose was inverted by boiling half an hour with slight excess of dilute hydrochloric acid. The inverted sugar thus formed was then treated with large excess of Fehling's solution, exactly as above described, except that it was not necessary to keep the temperature lower than the heat of the water bath (100° C.).

The precipitated red suboxide of copper was then thoroughly washed with hot water by decantation and filtration (without aspiration usually) through fine paper. It was then dissolved in an acid (sulphuric) solution of ferric sulphate, and the amount of ferrous salt determined by titration with potassium permanganate.

This method for determining glucose depends upon the following facts:

1. That two molecules (360 parts by weight) of glucose ($C_6 H_{12} O_6$) will reduce from Fehling's solution five molecules of cuprous oxide ($5 Cu_2 O$).

2. That the five molecules of cuprous oxide thus precipitated will reduce in acid sol. five molecules of ferric sulphate ($Fe_2 (S O_4)_3$) to form ten molecules (1,520 parts by weight) of ferrous sulphate ($Fe S O_4$) as is explained by the following equation:

$$\left\{\begin{matrix} 5 Cu_2 O \\ 715 \text{ parts} \end{matrix}\right\} + \left\{\begin{matrix} 5 Fe_2 (S O_4)_3 \\ 2{,}000 \text{ parts} \end{matrix}\right\} + \left\{\begin{matrix} 5 H_2 S O_4 \\ 490 \text{ parts} \end{matrix}\right\} = \left\{\begin{matrix} 10 Cu S O_4 \\ 1{,}595 \text{ parts} \end{matrix}\right\} + \left\{\begin{matrix} 10 Fe S O_4 \\ 1{,}520 \text{ parts} \end{matrix}\right\} + \left\{\begin{matrix} 5 H_2 O \\ 90 \text{ parts} \end{matrix}\right\}.$$

The ten molecules of ferrous sulphate thus formed will decolorize one molecule (316.2 parts by weight) of potassium permanganate ($K_2 Mn_2 O_8$), thus:

$$\left\{\begin{matrix} 10 Fe S O_4 \\ 1{,}520 \text{ parts} \end{matrix}\right\} + \left\{\begin{matrix} K_2 Mn_2 O_8 \\ 316.2 \text{ parts} \end{matrix}\right\} + \left\{\begin{matrix} 8 H_2 S O_4 \\ 784 \text{ parts} \end{matrix}\right\} = \left\{\begin{matrix} 5 Fe_2 (S O_4)_3 \\ 2{,}000 \text{ parts} \end{matrix}\right\} + \left\{\begin{matrix} 2 Mn S O_4 \\ 302 \text{ parts} \end{matrix}\right\} + \left\{\begin{matrix} K_2 S O_4 \\ 174.2 \text{ parts} \end{matrix}\right\} + \left\{\begin{matrix} 8 H_2 O \\ 144 \text{ parts} \end{matrix}\right\}$$

By following this explanation, it appears that two molecules of glucose are exactly represented by one molecule of potassium permanga-

nate, as will appear from the following, by omitting the second and third members of the series. Thus:

$$\left\{ \begin{matrix} 2\,C_6\,H_{12}\,O_6 \\ 360 \text{ parts} \end{matrix} \right\} = \left\{ \begin{matrix} 5\,Cu_2\,O \\ 715 \text{ parts} \end{matrix} \right\} = \left\{ \begin{matrix} 10\,Fe\,S\,O_4 \\ 1{,}520 \text{ parts} \end{matrix} \right\} = \left\{ \begin{matrix} K_2\,Mn_2\,O_8 \\ 316.2 \text{ parts} \end{matrix} \right\}$$

In other words, 316.2 parts by weight of potassium permanganate are equivalent to 360 parts of glucose, or one part of permanganate corresponds to 1.1385 parts of glucose. If, then, the amount of permanganate decolorized be multiplied by 1.1385 it will correctly represent the amount of glucose present. So much for the theoretical explanation. In practice it is found that each chemist must determine for himself his titration error by estimations made upon sugar of known purity.

This individual error is due to the difficulty in determining the exact end reaction; experience has shown, in the course of this work, that the point where the color of the permanganate barely appears in the rapidly agitated liquid is nearly identical with the true end reaction. Some operators carry the titration a little further until a faint rose tint is permanent for about two seconds. Each man who has done this work has carefully determined his titration error, and all figures submitted have been corrected therefor. The iron solution works best if very strongly acidulated with sulphuric acid. The most convenient strength for the permanganate solution is 4.392 grams to the liter, equal to .005 grams glucose for each cubic centimeter.

In the earlier part of these determinations it was not considered necessary to thoroughly wash the precipitated suboxide of copper before dissolving it in the ferric sulphate solution. Carefully performed experiments, however, showed that washing was best, and that the results obtained on unwashed suboxide would equal those on the washed if multiplied by .9676 for glucose and by .9438 for sucrose.

As the results of much careful work, it appears that if the suboxide be well washed, and if each operator determines his titration error, the determination of glucose by this method is very accurate.

The amount of glucose found was divided by the weight of 8 c. c. of the juice analyzed for percentage of glucose. The sucrose was found by subtracting from the total glucose after inversion the amount originally present in 4 c. c. of the juice, and multiplying the remaining glucose by .95. The percentage was then calculated in the usual way.

SUGAR BEETS.

Seven samples of beet-roots in their natural condition and one sample of sliced and dried root have been received and tested. Table No. I gives the names and addresses of senders and dates of analyses. No information has been received concerning the kind of seed sown, except from the sender of samples 1, 2, and 3, and none in any case as to fertilization, cultivation, or crops obtained. Table No. II gives the results of analytical tests, and shows that only two roots, samples 1 and 3, come up to the requirement for a good sugar-beet, these being the only ones which contain not less than 80 per cent. of cane sugar in the soluble matter of the juice. The juice of sample 2 contains 0.8 per cent. more of cane sugar than sample 3, but also contains 1.9 per cent. more of matter not sugar, thus bringing the proportion of cane sugar in the soluble matter down to 73.3 per cent., and causing this sample to rank the poorest but one in the list in this respect.

Analyses of sugar beets.

I.

Number.	Sender.	Sender's address.	Date received.	Kind of seed sown.
1	William Cartwright	Oswego, N. Y.	April 19, 1880	Imperial.
2	William Cartwright	...do	...do	Do.
3	William Cartwright	...do	...do	Do.
4	E. M. Rugg	Peabody, Kans	March 16, 1880	
5	Charles Rhondes	Vineland, N. J.	February 3, 1880	
6	E. M. Rugg	Peabody, Kans	March 16, 1880	
7	A. D. Coffee	Perry, Iowa	December 17, 1879	

II.

Number.	Mean weight of root in pounds.	Per cent. of juice expressed from root.	Per cent. of sucrose in juice.	Per cent. of foreign matter in juice.	Per cent. of sugar in soluble matter of juice.	Per cent. of sugar obtained from root.	Specific gravity of juice.	Per cent. by weight of root below leaf-marks.
1	2.2	53.7	14.3	2.4	85.6	7.7	1.075	88.5
2	1.8	47.0	10.7	3.9	73.3	5.0	1.067	83.6
3	1.9	64.2	9.9	2.0	83.2	6.4	1.053	93.0
4	1.4	56.2	9.7	2.6	79.2	5.5	1.058	78.4
5	1.1	49.3	9.4	4.3	68.6	4.6	1.063	89.8
6	2.2	53.6	9.0	2.5	78.3	4.8	1.055	77.0
7	4.9	60.0	8.9	2.7	76.7	5.3	1.060	86.0

Analysis of sugar-beet sliced and dried.

From J. S. Pitman, Providence, R. I.

Water was added to the dried powdered root in quantity to make the moisture of the material 77.3 per cent. From this mixture 67.9 per cent. of juice, specific gravity 1.036, was obtained, which gave, calculated to the dry root—

	Per cent.
Sucrose	17.21
Glucose	1.31

The press-cake from the foregoing operation was exhausted three times in succession with water, each time an amount being taken equal to ten times the weight of root taken; from these combined washings the following results calculated to the dry root were obtained:

	Per cent.
Sucrose	8.30
Glucose	0.43

The combined results are—

Water	9.24
Total sucrose	25.51
Total glucose	1.79
Undetermined	63.46
	100.00

ANALYSES OF MARLS, SOILS, CLAYS, ETC.

Frequent applications are made to the department for analyses of marls, soils, clays, peat, and similar substances, and referred to this division, and in many cases the analyses have been made, the results of some of which are given in the following pages.

It is obviously impossible to comply with all the demands made for such work, and in view of the purely local, if not personal, character of the work, it hardly seems desirable that the limited force in the labora-

tory should be employed in such analyses. To be of any value practically, the analysis must be thoroughly performed, and few are aware of the time required and labor involved in making a complete analysis, and, as will be seen, it not infrequently happens that specimens of marl, &c., submitted for examination are quite worthless, and the time given to their analysis practically lost. The same remark applies to ores, minerals, and mineral waters, of which there are very many specimens received from all parts of the country, generally from those without much knowledge concerning the general character of the specimens sent, which specimens almost always prove worthless.

Constituents.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Water	16.80	3.98	9.16	17.42	10.65
Organic matter	2.18				
Sand	36.55	53.32			
Lime	6.00		38.09	.86	.18
Magnesia	2.28	.33	2.33	.29	Trace.
Iron oxide	15.94	1.96	3.48	.81	Trace.
Alumina		10.60	7.63	32.34	36.66
Potassa	2.69	.30	.80	2.40	
Silicic acid (combined)		29.96	23.31	45.69	51.49
Chlorine	.14				
Sulphuric acid	Trace				
Phosphoric acid	Trace				
Carbonic acid	16.96		9.59		
	99.54	100.45	94.39	99.81	98.98

No. 1.—Green sand marl from Meridian, Miss.
No. 2.—Clay from Maryland.
No. 3.—Clay from Potomac Terra Cotta Company.
No. 4.—Kaolin from Maryland.
No. 5.—Kaolin from Virginia.

Constituents.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sand and clay	42.60	42.67	35.29	2.00	87.71	65.72
Iron oxide					6.23	
Alumina						
Carbonate of lime	57.40	57.33	64.71	98.00	1.22	3.82
Organic matter					4.84	26.44
Water						4.02
Phosphoric acid	Traces	Traces	Traces	.11	Traces	
Potassa	Traces	Traces	Traces			
	100.00	100.00	100.00	100.11	100.00	100.00

Constituents.	No. 7.	No. 8.	No. 9.	No. 10.	No. 11.	No. 12.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Sand and clay	59.07	81.10	62.42	1.52	4.70	83.29
Iron oxide		10.50				
Alumina						
Carbonate of lime	40.93		36.00	96.99	94.30	16.71
Organic matter				1.49		
Water		8.40			1.00	
Phosphoric acid	Traces		.55	Traces		Traces.
Potassa	Traces		.40	Traces		Traces.
	100.00	100.00	99.37	100.00	100.00	100.00

Nos. 1, 2, 3. Marls from Enterprise, Miss.
No. 4. Marls from Union County, Florida.
No. 5. Greensand marl from Still Pond, Md.
No. 6. Soil "burned" from Dismal Swamp.
No. 7. Marl from Calhoun Station, Miss.
No. 8. Ochreous marl from Virginia.
No. 9. Marl from Green Cove Springs, Fla.
No. 10. Limestone from Cedar Springs, Pa.
No. 11. Marl from Manistee, Mich.
No. 12. Marl from Boydton, Va.

SOIL FROM SMALL MANGROVE ISLAND, OFF THE FLORIDA COAST.

Received from Prof. S. F. Baird.

This was a peaty mixture, containing considerable undecomposed woody matter. Owing to the small amount received a partial examination only was made.

Water and volatile matter*	22.76
Soluble in nitric acid†	44.85
White sand	32.39
	100.00

The presence of so large a quantity of phosphate of lime in the above sample appears to indicate an extensive deposit of this mineral in the immediate vicinity where the sample was obtained.

UNPRODUCTIVE SOIL.

From L. Allen, Oak Hill, Volusia County, Florida.

The analysis of this soil shows that its barrenness is very likely due to a lack of constituents suitable for plant nourishment, and not to the presence of any injurious substance.

It contains—

	Per cent.
Moisture	1.05
Organic matter	7.60
Soluble in acid	2.60
White sand	89.35
	100.60

PEATY SOIL.

Received from William W. Wood, Jutland, near Point Lookout, Saint Mary's County, Maryland.

A water extract from this soil had an acid reaction and gave decided reactions for sulphates and chlorides of iron, lime, magnesia, potash, and soda, together with a little organic matter. This water extract amounted to 11.84 per cent. of the original soil, and consisted of—

Sodium chloride, $NaCl$ (common salt)	.15
Potassium chloride, KCl	.46
Magnesium chloride, $MgCl_2$	.92
Potassium sulphate, K_2SO_4	2.68
Calcium sulphate, $CaSO_4$	1.47
Iron sulphate (copperas), $FeSO_4$	2.45
Iron sulphate, ferric, $Fe_2(SO_4)_3$	3.02
Organic matter, by difference	.69
	11.84

The large amount of soluble iron salts is remarkable. They are injurious to crops except when present in very small quantities. On the other hand, the considerable amount of potash is a favorable indication. It would be best to allow the air to have free access to this soil, so that the soluble salts of iron may become insoluble and harmless.

*Includes 1.008 per cent. of nitrogen, equivalent to 1.224 per cent. of ammonia (NH_3).

†Includes 13.74 per cent. of phosphoric acid (P_2O_5), equivalent to 30.00 per cent. of phosphate of lime, ($Ca_3(PO_4)_2$); also some carbonate and a trace of potash.

LEAF MOLD.

Received from J. F. Armour, Manistee, Mich.

Examined for heating purposes, gave as follows:

The sample was first dried and pulverized.

Moisture	8.48
Ash	17.96
Bituminous matter	51.98
Coke	21.58
	100.00

When dried the heating value of this sample would be approximately the same as that of dry peat.

Its fertilizing value is represented by 2.10 per cent. of nitrogen, equivalent to 2.55 per cent. of potential ammonia; a trace of phosphoric acid was present, but no potash. As an addition to a compost heap it would probably prove valuable.

COMMERCIAL FERTILIZERS.

As in former years, a considerable number of commercial fertilizers has been analyzed and reports made upon their value. Nearly all these fertilizers have had a local reputation, good or bad, in the sections from which they came, but it seems hardly advisable to print their analyses here, because they are of interest to only a very few persons. At the same time it is very important that the farmer, who is obliged to buy fertilizers, should thoroughly understand what constituents give value, and what others merely add weight. It has been found as the result of experience that the following substances are necessary to the plant that it may grow and mature properly.

I.—NITROGEN.

It is not proven, and it seems very doubtful, whether any part of the nitrogen absorbed and assimilated by plants is derived directly from the free nitrogen in the air. On the other hand, abundant evidence exists that ammonia, or any substance which can furnish it, and nitrates have direct and positive effects for good on growing plants. No plant has ever been examined which did not contain a greater or lesser proportion of nitrogenous constituents at all stages of its development, and in all its essential organs. The amounts of nitrogenous constituents vary greatly in different families of plants, in different members of the same family, and in each individual at different stages in its growth. Hence an intelligent discrimination should be made in applying nitrogenous fertilizers, in order that the necessities of the growing plant may be satisfied without excessive waste and expense for the fertilizer. Nitrogen may be furnished to the plant in three ways, viz:

a. As actual ammonia.

Free ammonia gas (NH_3) is liberated from many substances when putrefying, and carbonate of ammonium ($(NH_4)_2CO_3$) always results from the decomposition of urine, stable manure, &c. In these forms ammonia has the characteristic pungent odor of "hartshorn," so well known. Besides these familiar sources, the distillates from gas-works and those obtained in charring bones, &c., for the manufacture of animal charcoal ("bone black"), furnish large quantities of ammonia, which is made into a white crystalline sulphate ($(NH_4)_2SO_4$), and thus furnished

to the trade. This sulphate of ammonium varies in color from pure white to nearly black, according to the quantity of tarry impurities present. It has no odor when pure, and only a slight tarry odor when quite impure. A pure sample yields upon analysis 25.75 per cent. of ammonia gas (NH_3); commercial samples are valuable just in proportion to the amount of ammonia they yield upon analysis.

The following analysis represents the composition of a very good commercial sample:

Analysis of commercial ammonium sulphate.

Moisture, loss at 110° C	.23
Iron oxide (FeO)	.23
Volatile tarry substances, by difference	1.17
Ammonia (NH_3)	25.66
Sulphuric acid (SO_3)	60.64
Oxygen, corresponding with ammonia	12.07
	100.00

These constituents were combined as follows:

Moisture	.23
Volatile tarry substances	1.17
Iron sulphate ($FeSO_4$, with trace $Fe_2(SO_4)_3$)	.49
Ammonium sulphate ($(NH_4)_2SO_4$)	98.11
	100.00

Probably there is no better way of applying ammonia to the soil than in the form of ammonium sulphate.

Nitrogen may also be furnished to crops as—

b. Potential ammonia.

By the term "potential ammonia" we understand that the substance spoken of contains a certain quantity of nitrogen, which, under favorable conditions, may have a food value equivalent to a certain amount of ammonia. The substances which contain nitrogen that may furnish this potential ammonia are various both in chemical composition and physical form. Some of the principal kinds will be enumerated.

1.—*Excrements.*

Ordinary *barn-yard manure*, if properly housed and applied, is one of the most valuable of fertilizers. It is very complex in its chemical composition, but contains a very considerable amount of nitrogen in such a form as to readily furnish nitrogen to the growing plant. The urine of animals is also rich in valuable nitrogenous matters, and when properly applied will well repay the cost for storage and handling. Besides these common forms there are a number of localities in our Southern States where *bat excrements* are found, usually in caves. These excrements are very rich in potential ammonia, and have proven very valuable fertilizers. In the annual report of this department for 1876, pp. 49 to 52, will be found several analyses of bat guano. A sample this year received from M. W. Townsend, Austin, Tex., contained the following valuable constituents: Total nitrogen, 11.088 per cent., equivalent to 13.464 per cent. potential ammonia; Potassium oxide (K_2O), .91 per cent.; and Insoluble Phosphoric acid (P_2O_5), 6.18 per cent.

Guano is another excrementitious substance which has been abundantly used and with excellent results. It is rich in nitrogen in a readily available form. It should only be bought upon analysis of some reliable chemist, as many inferior imitations are sold by unprincipled parties.

Analysis of a so-called "guano."

Water	14.96
Organic and volatile*	23.05
Soluble in water and acids	51.01
Sand and clay	10.98
	100.00

The following were the valuable mineral constituents:

	Per cent.
Phosphoric acid, soluble (P_2O_5)	5.92
Phosphoric acid, reverted (P_2O_5)	6.34
Phosphoric acid, insoluble (P_2O_5)	6.27
Potassium oxide (K_2O)	2.23

2.—*Animal and vegetable refuse.*

Dried blood, meat scraps, fish and fish-offal, gelatine and glue waste, the pomace left after expressing the oil from castor, linseed, and cotton seeds, are all valuable sources of nitrogen. Very much depends, however, upon their mechanical condition, and in estimating their value due regard must be had to their fineness, freedom from moisture, &c.

Of very much lower and more variable value are such substances as hair, wool, and shoddy waste, clippings of hides, horn scraps, &c. Although these substances may furnish, upon analysis, considerable potential ammonia, their compact texture or indestructible character prevents them from decaying rapidly enough to be of any marked value to the growing crop. An examination of shoddy waste gave the following results:

"Shoddy waste."

From "West Riding Shoddy Works Company," Dewsburg, England.

Constituents.	First estimation.
Moisture	6.07
Organic matter†	85.63
Ash	8.30
	100.00

It is very doubtful whether this would prove of any direct fertilizing value.

A good many other waste products are used with varying success. Great care should be taken in their selection, and, if possible, the opinion of an experienced chemist should be had. The third form in which nitrogen can be applied to plants is in the form of *nitrates.*

c. Nitrates.

The only cheap nitrate at present used as a fertilizer is nitrate of sodium ($NaNO_3$), commonly known as Chili saltpeter or Chili niter. Its value depends upon its percentage of nitrogen. When perfectly pure and dry this salt contains 16.47 per cent. of nitrogen; but in practice this amount is not reached, owing to the presence of impurities and to the fact that this salt readily absorbs water from the air. Nitrates are the most expensive sources of nitrogen.

II.—POTASH SALTS.

Equally valuable and necessary to the growth of a plant are salts of potash. They are valuable in proportion to the amount of potassium

*Potential ammonia in organic matter, 5.40 per cent.

†Contains of potential ammonia, 2.76 per cent.; 2.73 per cent.

oxide (K_2O) they can furnish. The principal forms used are *wood ashes*, in which the potash exists in variable amounts, chiefly as carbonate (K_2CO_3); *chloride of potassium* (KCl), commonly known as "muriate of potash," and *sulphate of potassium* (K_2SO_4).

These salts, when pure, contain the following amounts of potassium oxide:

	Per cent. of potash.
Potassium carbonate contains	68.16
Potassium chloride contains	63.17
Potassium sulphate contains	54.08

The commercial salts are never pure, but an analysis showing their content in potash serves to fix their value. Potassium carbonate is not sold in the markets to any great extent except for soap-making. Applied in moderate quantities in the form of wood-ashes, it is valuable, but used in excess, it acts as a caustic injurious to plants. It is customary to sell potassium oxide in the crude chloride ("muriate") at a somewhat lower rate than it commands in the form of sulphate. There seems to be two reasons for this discrimination: firstly, potassium chloride can be produced more cheaply; secondly, it is strenuously held by some that the effects of equal amounts of potash in the forms of chloride and sulphate are decidedly to the advantage of the sulphate. At the same time the Connecticut Agricultural Experiment Station* has shown that several of the much-praised sulphates were more properly chlorides. Whether this preference for the sulphate is based upon facts or on theory is certainly worth careful experimentation, that some definite conclusions may be reached.

III.—PHOSPHORIC ACID.

Phosphoric acid as such is not used, but it is supplied usually as a phosphate of lime, either in ground and otherwise prepared bone or as a superphosphate of lime prepared from bone, rock guanos, apatite, rock phosphates, and phosphatic marls, such as those found abundantly in South Carolina and other portions of this country.

Phosphoric acid (or, more strictly, phosphoric oxide—P_2O_5) exists in fertilizers in three conditions of very different commercial and agricultural value. In the order of their value for fertilizing purposes they are known as *soluble*, *reverted*, and *insoluble* phosphoric acid. These will be separately described:

1.—*Soluble phosphoric acid.*

This exists as an acid phosphate of lime ($CaO.2H_2O.P_2O_5$), and is formed by treating bones with a proper quantity of sulphuric acid ("oil of vitriol," H_2SO_4). This acid phosphate is freely dissolved by water, and has been proven to be more promptly useful than either "reverted" or "insoluble" phosphates of lime.

2.—*Reverted phosphoric acid.*

This is also combined with lime, but in a different proportion. This lime salt is represented by the symbol ($2CaO, H_2OP_2O_5$). Reverted phosphate of lime results from a change that occurs upon long keeping of the soluble phosphate. It is not soluble to any appreciable extent in water, but in the processes of analysis is dissolved in a solution of

*Annual Report Conn. Agric. Exp. Sta., p. 37, (1879.)

ammonium citrate. Its fertilizing action is believed not to be as prompt as is that of soluble phosphates, still it is far more valuable than insoluble phosphate.

3.—*Insoluble phosphoric acid.*

Insoluble phosphate of lime ($3CaOP_2O_5$) is not soluble either in water or in ammonium citrate solution. Its effect upon crops is comparatively slow, and its agricultural value depends upon the condition in which it exists, since if in bones its value is much greater than in the form of pulverized mineral phosphate.

SUPERPHOSPHATES.

Superphosphates are commercial fertilizers in which all or a part of the phosphoric acid has been rendered soluble by treatment with sulphuric acid. In a recent well-prepared superphosphate nearly all the phosphoric acid is in a soluble condition; in practice, however, this is usually not found to be the case. Either by improper methods of manufacture or by long keeping part of the phosphoric acid becomes "reverted," and part occurs as "insoluble." Hence, analyses of phosphatic manures, to be of value, should state definitely the amount of each form of phosphoric acid.

A high-grade superphosphate, which had been very carefully made, contained practically all its phosphoric acid in the soluble form. Analysis showed that it amounted to 15.20 per cent.

The two following analyses show the composition of ordinary samples of superphosphates.

Analyses of fertilizers.

Constituents.	No. 1.	No. 2.
Moisture, loss by drying at 110° C	18.37	12.19
Volatile organic matter	2.79	†27.60
Sand and clay insoluble in acids	7.50	2.91
Oxides of iron and alumina	6.99	.48
Lime, CaO	21.50	29.74
Magnesia, MgO	3.33	
Potash, K_2O	1.50	.31
Soda, Na_2O	.10	Trace.
Ammonia, NH_3 (= .35 per cent. nitrogen)*	.43	None free.
Sulphuric acid, SO_3	22.72	9.68
Phosphoric acid, soluble	6.83	1.28
Phosphoric acid, reverted	5.14	13.90
Phosphoric acid, insoluble	2.80	1.91
Total	100.00	100.00

VALUATION OF FERTILIZERS.

The *commercial value* of a fertilizer can be approximately deduced from the results of analysis; it is chiefly dependent upon the market value of the crude materials which are used in its manufacture. The *agricultural value* of the same fertilizer is a variable quantity, and depends to a considerable extent upon the soil to which it is applied, the heat, moisture, and various climatic conditions. The same fertilizer under different circumstances may give good or indifferent results which cannot justly be charged to the fertilizer alone. Under average, nor-

* Total nitrogen, .58 per cent., equivalent to .70 per cent. ammonia, of which .43 per cent. was *actual* and .27 per cent. *potential.*

† Total nitrogen, 2.70 per cent., equivalent to 3.28 per cent. of ammonia, *all potential.*

Nitrates were absent in both fertilizers.

mal conditions of soil, rainfall, &c., the commercial and agricultural values should correspond reasonably well, but under other than proper conditions the agricultural value must be chiefly determined by experiment.

That the purchaser may be able to estimate the commercial value of a fertilizer from the results of an analysis a table of trade values is here appended. It is taken from the report of the Connecticut Agricultural Experiment Station for 1879, p. 18, and applies to the New York markets. It seems to be a very just statement of the value of those ingredients known to be of fertilizing value.

Trade-values for 1879 *and* 1880.

Connecticut Agricultural Experiment Station:

	Cents per pound.
Nitrogen in nitrates	26
Nitrogen in ammonia salts	22½
Nitrogen in Peruvian guano, fine steamed bone, dried and fine ground blood, meat, and fish	20
Nitrogen in fine ground bone, horn, and wool dust	18
Nitrogen in fine medium bone	17¼
Nitrogen in medium bone	16½
Nitrogen in coarse medium bone	15¾
Nitrogen in coarse bone, horn shavings, hair, and fish scrap	15
Phosphoric acid, soluble in water	12½
Phosphoric acid, "reverted," and in Peruvian guano	9
Phosphoric acid, "insoluble," in fine bone and fish guano	7
Phosphoric acid, "insoluble," in fine medium bone	6½
Phosphoric acid, "insoluble," in medium bone	6
Phosphoric acid, "insoluble," in coarse medium bone	5½
Phosphoric acid, "insoluble," in coarse bone, bone ash, and bone black	5
Phosphoric acid, "insoluble," in fine ground rock phosphate	3½
Potash in high grade sulphate	7½
Potash in low grade sulphate and kainite	6
Potash in muriate or potassium chloride	4½

The following values for 1879–1880 have been adopted by the Commissioner of Agriculture of the State of Georgia:

Georgia trade-values for 1879–1880.

	Cents per pound.
Soluble and reverted phosphoric acid, called "available phosphoric acid"	12½
Ammonia	18
Potash	8

No value is given to insoluble phosphoric acid, and no distinctions are made between actual and potential ammonia. The mechanical condition of the fertilizer is not recognized as affecting its value. The prices are for Savannah, Georgia.

In applying these prices multiply the per cent. of each valuable ingredient by its price per pound, and this result by twenty. The product represents the value of each ingredient in a ton (2,000 pounds) of the fertilizer.

Accurate experiments are still needed to ascertain the value, if any, of insoluble phosphoric acid, the comparative fertilizing values of soluble and reverted phosphoric acid, and the comparative values of sulphate and chloride ("muriate") of potash. It is hoped that the government may provide means for the careful investigation of these very important questions, the final settlement of which would have a real and great money value to the farmers of this country.

MISCELLANEOUS.

BUTTER AND OLEOMARGARINE.

During the present year, as in the past, the department has been called upon to decide whether the samples submitted for examination were true butter or artificial imitations thereof. Several samples that proved upon analysis to be oleomargarine had been sold for veritable butter, while others were sold under their proper name.

It must be admitted that carefully prepared oleomargarine is superior to poor butter as regards taste, odor, and healthfulness; at the same time it is hardly probable that it will ever be preferred to butter of good quality. It cannot rightfully be sold as butter, but should be disposed of under its proper name, "oleomargarine," in order that consumers may obtain exactly what they wish. There can be no valid objections urged against the manufacture and sale of good oleomargarine if no deception is practiced upon the buyer. This whole matter has been thoroughly tested in English courts; the law there makes it a misdemeanor to sell any article of food, drink, or medicine under any false or misleading name. A law, carefully framed, is greatly needed in this country, where adulteration and substitution are every day practiced.

The most trustworthy method for the analysis of butter and other fats is that originally proposed by Hebner and Angell; it is based upon the fact that butter-fat contains from 85.5 to 89.6 per cent. of insoluble fatty acids, while animal fats procured from tissues contain from about 90 to 95.5 per cent. of insoluble fatty acids. Butter-fat also contains about 5 to 6 per cent. of soluble fatty acids (chiefly butyric acid) combined also with glycerine in the fat. For all the best methods for analysis of fats see The Analyst (London), vols. I and II.

Eight analyses of butter and oleomargarine will be found in the department report for 1878, p. 135.

Analyses of butter and oleomargarine.

No.	Sold as—	Fats.	Casein.	Salt.	Water.	Total.
I.	No. 2, New York dairy butter	84.14	2.00	3.66	9.91	99.71
II.	Oleomargarine, sold as New Jersey dairy butter	85.58	.92	4.42	8.52	99.41
III.	Oleomargarine, first analysis	87.35	1.68	2.55	8.42	100.00
IV.	Oleomargarine, second analysis	87.62	.92	2.64	8.86	100.04

Constituents.	Per cent. of fats.
Insoluble fatty acids in No. 1	86.13
Insoluble fatty acids in No. 2	90.80
Insoluble fatty acids in No. 3	93.72

ALCOHOLIC LIQUORS.

In the examination of alcoholic liquors chemical analysis is certainly very important; by this means a practiced analyst can determine in most cases whether the sample is what it pretends to be or whether it is merely a mixture of raw spirit with various aromatic coloring and other substances.

Alcohol, sugar, tannin, acids, jelly-forming (pectinous) substances, water, and ash can also be estimated with reasonable accuracy.

At the same time it is hardly practicable to estimate in liquors of excellent quality those ethers which impart "bouquet," and to a great extent value to the sample. The trained senses of an expert are here of more value than the chemical analysis. The American market is flooded with vile wines and brandies which are in fact nothing but poor raw whisky, flavored, colored, and sophisticated according to the whims and caprices of professional "improvers."

The samples of native wines that have been analyzed this year have not been of first quality. They were not received, however, from those sections of the country where wine-making has been carried to its greatest perfection.

Wines.

Constituents.	No. 1.	No. 2.	No. 3.
Per cent. alcohol, by weight	7.4	8.8	7.2
Per cent. total acid, as tartaric	.602	.499	.391
Per cent. acetic acid	Trace.	Trace.	.310
Per cent. total residue, organic	1.896	1.595	2.030
Per cent. ash	.226	.197	.260
Per cent. cane sugar	Trace.	Trace.	.170
Per cent. grape sugar	Trace.	Trace.	.360
Per cent. tartaric acid	Not determined.	Not determined.	.14
Per cent. tannin and extractives	Not determined.	Not determined.	1.36
Specific gravity	.99676*	.99250*	.99292

* Nos. 1 and 2 at 17.5° C.; No. 3 at 28.5° C.

Nos. 1 and 2 were received from John G. Klein, Cullman, Ala. No. 1 was a very dark-colored sample, and had a pleasant odor, due to the grape used (thought to be Ives' seedling), but it had a decidedly astringent after-taste. No. 2 had a light color and no distinctive odor, nor was its taste pleasant. Both of these wines would probably have been improved by the addition of a moderate amount of sugar to the expressed juice; also a less heavy pressure of the seeds and skins would, to a considerable extent, have prevented the removal therefrom of the tannic acid to which was due the unpleasant astringency of the wine.

No. 3 was a low-grade, rather acid wine, received from T. J. Stevens, of Washington, D. C. The most noticeable abnormal constituent was the high amount of acetic acid. Those wines containing over 20 per cent. of acetic acid are condemned by judges as "soured," although many are sold of about the character of this No. 3. The alcoholic strength of these wines is low. None of them gave evidence of adulteration.

A number of other specimens have been partially examined, but owing to insufficient samples their analysis cannot be given.

Samples for analysis should contain at least a pint.

Distilled liquors.

	"Whisky" No. 1.*	Whisky No. 2.*	"Gin".†	Brandy.‡
Specific gravity	.97110 (28.5° C.)	.92600 (25.5° C.)	.93428 (20° C.)	.94906 (21.5° C.)
Per cent. alcohol, by weight	29.3	43.00	40.50	36.00
Per cent. alcohol, by volume		50.00	48.00	43.00
Per cent. total residue	8.09§	Trace.	.05	.08
Per cent. free acid, as acetic			.03	.05

No. 2 was a very raw whisky containing traces of fusel-oil. It was claimed that No. 1 was made from this same No. 2 by some mysterious

* Nos. 1 and 2 from T. H. Russell, Washington, D. C.
† Gin in bottle marked "Hall & Hume, Washington, D. C."
‡ Brandy from General Henry M. Naglee, San José, Cal., "vintage of 1871, distillate of 1872."
§ This residue was all *sirup*.

and secret process whereby all fusel-oil and harmful impurities were removed. A careful examination showed that the mysterious addition was *sirup*, and it is very probable that No. 1 was made from a much purer form of dilute spirit than was No. 2. The amount of solid residue in No. 1 was entirely without precedent, and the liquor could not properly be called whisky.

The "gin" was a vile mixture of raw whisky with considerable oil of juniper and a little tannin. It became very turbid when diluted with an equal volume of water. A veritable gin, properly made by distillation, should become only slightly opalescent when so diluted.

The brandy was a very fine specimen that gave abundant evidence that it was what all brandy should be, viz., distilled from pure grape-wine. This sample possessed a "bouquet" and slight color (not due to caramel) that gave evidence of considerable age, and also of skill on the part of the maker.

IMPROVED GREEN COFFEE BERRIES.

There were received from the Committee on Adulterations of the House of Representatives six samples each of natural coffee berries, and of the same berries after they had been "improved" by being faced with colored powders. They also sent three powders, which it was claimed are used to give color, weight, and increased market value to raw coffee.

The composition of these powders was as follows:

ORANGE POWDER.—Chromate of lead ("chrome yellow"), 1 part; sulphate of barium ("heavy spar"), 2 parts.

BLACK POWDER.—Consisted wholly of burnt bones ("crude bone black").

OLIVE-GREEN POWDER.—Chromate of lead ("chrome yellow"), 1 part; bone black, 2 parts; sulphate of barium ("heavy spar"), 3 parts.

Both the natural and the faced berries were examined with the result that every sample of the "improved" berries was found to have been treated with some powder containing the same substances as those in the above olive-green powder.

The amounts of foreign adulterants were—

	Per cent.		Per cent
No. 1	68	No. 4	64
No. 2	19	No. 5	63
No. 3	08	No. 6	58

The "uncolored" berries were what was claimed for them, viz., free from any adulteration.

There can be but little doubt that these added coloring matters must prove injurious, and, probably, directly poisonous to the consumer. Especially is chromate of lead liable to be changed by roasting, so that its lead may be soluble in the acids of the stomach; and it is well known that soluble lead salts have a decidedly poisonous action.

Laws should be made and vigorously enforced making the adulteration of foods and medicines a criminal offense. Where life and health are at stake no specious arguments should prevent the speedy punishment of those unscrupulous men who are willing, for the sake of gain, to endanger the health of unsuspecting purchasers.

AN EXAMINATION OF "TUCKAHOE."

The name "Tuckahoe" is thought to have been the Indian name for bread. It is applied to a subterranean fungus which is found attached to the roots of dead trees* in Virginia and others of our Southern

* The National Dispensatory, 1st. ed., p. 864, states that tuckahoe is usually attached to the roots of fir trees, but it is not stated whether the trees are living or dead.

States, and even so far west as Kansas. Little doubt remains as to its being identical with the fungus commonly sold in China as an article of food, under the reported names "fuh-ling, pe-fuh-ling,"* or "pu-fuh-ling."†

Flückiger cautions against confounding it with the root of Smilax China ("China root") which also grows in our Southern States, and is known in China as "tu-fuh-ling."

In Virginia it is said to be commonly known as "Indian bread," or "Nigger-head." The scientific names assigned by various writers are quite numerous. That given by Fries, *Pachyma cocos*, seems most widely accepted at present. Torrey, who made the first chemical examination, described it as *Sclerotium giganteum.*

Among other names are the following: *Pachyma solidum*, Oken; *P. coniferarum*, Horaninou; *Lycoperdon cervinum*, Walter; *L. solidum*, Gronovius; *Sclerotium cocos*, Schwienitz.

The first careful chemical examination of tuckahoe was made by Prof. John Torrey, in 1819.‡ He found the fungus to consist almost entirely of a hitherto undescribed substance—not starch—which had the property of forming a jelly when heated with water and allowed to cool. To this substance he assigned the name "sclerotin." The later researches of Braconnot on the jelly-forming constituents of fruits and tubers were published in 1824,§ and led to the adoption of the term "pectous substances." In 1827|| Torrey republished his original article with additions, and demonstrated that the substance he had named "sclerotin" was identical with the "pectic acid" of Braconnot. In this conclusion he was certainly correct, as this gelatinous substance deports itself exactly like pectic acid, as described in the standard text-books on proximate analysis.¶

In 1875 an analysis was made at the Bussey Institute.** In this analysis the gelatinous substance is spoken of as pectose. In most respects the analysis there made agrees very closely with the one here reported. Trifling differences are to be ascribed to the examination of different samples.

Proximate analysis of "Tuckahoe."

Pachyma cocos, Fries.

Constituents.	Department of Agriculture.		Bussey Institute.
Moisture at 110° C	12.97		14.51
Ash	.24		.24
Albuminoids, soluble in alcohol not in water	.28	.79	1.33
Albuminoids, soluble in water not in alcohol	.51		
Carbohydrates:			
Tannin, like substance, soluble in water	1.25		
Gum	.20	79.88	73.73
Pectic acid, by difference	78.43		
Fatty substance, soluble in gasoline	.35		.34
Crude cellulose	5.77		9.80
	100.00		100.00

* Flückiger and Hanbury's Pharmacographia, 2d ed., p. 714, note 2.

† Rev. M. J. Berkeley "On Some Tuberiform Vegetable Productions from China," noticed in Amer. Jour. Sci. Arts, 2d series, vol. xxvii, p. 438 (1859).

‡ Med. Repository, N. Y., vol. vi, 37, 34 (1821).

§ Ann. Chim. Phys., xxviii, 173 (1824); others in Gmelin's Handbook, xv, 401.

|| Med. and Physical Journal, vi., 484 (1827).

¶ Prescott's Prox. Org. Anal., p. 166; Gmelin's Handbook, xv., 403; Watt's Dict. Chem., iv, 366.

** Bulletin of the Bussey Institute, 1875, p. 370.

The most noticeable peculiarities of this substance are the entire absence of starch,* the comparatively small amounts extracted by solvents, the gelatinous character of the cellulose, and the very small amount of albuminous substances.†

No other substance yet analyzed has been reported to contain so large a proportion of pectinous matter; in ordinary fruits, such as are commonly used for making jellies, these pectin bodies seldom amount to ten per cent. Torrey suggested that tuckahoe in fine powder would serve as the basis for edible jellies.

According to Sach's Botany "the origin of colloidal pectin * * * is still unknown." Its nutritive value seems also to be entirely undecided. The older writers considered the pectin bodies of no value as foods, while later authors seem inclined to give them a value approximating that of starch. It seems certain that a diet of tuckahoe alone would not sustain life, because of the lack of sufficient nitrogenous materials to repair the waste in the animal tissues; still it might prove, like our farinaceous articles of food, a valuable adjunct to highly nitrogenous foods.

No better material could be offered the botanist and physiologist than is tuckahoe for the decision of two questions, viz: How are the pectin bodies formed in plants, and what are their values as foods?

EFFECT ON CANE SUGAR OF COOKING WITH FRUIT.

Two Russet apples were pared and sliced, covered with cane sugar and baked for three hours at a rather low temperature. Then determinations were made of the amounts of unchanged cane sugar ("sucrose") and of inverted sugar ("glucose"). It was found that 60.64 per cent. of the cane sugar had been "inverted." This inverted sugar being less sweet, it follows that to get the full sweetening effect of cane sugar it should be added to fruit after cooking rather than before. It is very probable that all the cane sugar would have been changed to inverted sugar had the apples been more tart.

EXAMINATION OF LIGNITE.

From "Baby Mine," 40 miles west of Bismarck, Dak. Received from C. W. Thompson, Bismarck, Dak.

Moisture	17.81
Ash, light gray	4.67
Bituminous matter	56.50
Coke	21.02
	100.00
Total sulphur in coal	1.17 per cent.
Total sulphur in ash	.24 per cent.

ANALYSIS OF ROCK SALT.

From mine of American Rock Salt Company, Iberia Parish, Louisiana.

Sodium chloride	98.900
Calcium chloride	.146
Magnesium chloride	.022
Calcium sulphate	.838
Insoluble in water	.014
Moisture	.080
	100.000

* No fungus has yet been shown to contain true starch. (Sach's Botany, 241.)
† Most fungi are highly nitrogenous.

The above specimen was received from Ranger & Co., Galveston, Tex., and is said to fairly represent the whole deposit. If this be the case the mine is a very valuable one, as the salt is of excellent quality.

ANALYSIS OF SALTS FROM EVAPORATION OF LAKE WATER.

From A. F. Lewis, Lakeview, Oreg.

Moisture	7.60
Organic matter	1.83
Insoluble in water	.81
Sodium chloride, Na. Cl. (common salt)	54.83
Sodium sulphate, $Na._2$ $So._4$ (glauber salts)	2.02
Sodium carbonate, $Na._2$ $Co._3$ (sal soda)	32.86
	100.05

Another sample received from C. Moore, of Almota, Whitman County, Washington Territory, had a very similar composition. These alkaline waters are very valuable detergents, and are cheap sources of crystallized carbonate of sodium (sal soda), which is one of the most useful of chemicals. Three gallons of the Oregon sample are said to furnish one pound of mixed salts upon evaporation.

ORES AND MINERALS.

A large number of specimens have been received. In most cases an inspection showed them to be of no value. A few analyses have been made, but work of more strictly agricultural and general interest has been given the preference. A single specimen received from Northern New York has been carefully analyzed, because it appears to be a new mineral, containing the comparatively rare elements thorium and uranium. It closely resembles the mineral described by Dana (System of Mineralogy, p. 413), under the name Thorite; it differs chiefly in its much larger content of uranium. The name *Urano-thorite* is proposed as suitable. The following are its properties:

URANO-THORITE.

1. *Color.*—Dark-red brown.
2. *Luster.*—Resinous or sub-vitreous.
3. *Streak.*—Yellowish brown.
4. *Fracture.*—Conchoidal.
5. *Hardness.*—About 5. Scratches glass with difficulty, but is easily scratched by the knife.
6. *Specific gravity.*—4.1265.
7. *Fusibility.*—Infusible before the blow-pipe.
8. *Closed tube.*—Considerable water; residue red-brown.
9. *On charcoal.*—Heated alone becomes brown; no fumes or odor. With soda forms a dark grayish-brown bead, not magnetic.
10. *Salt of phosphorus, on platinum wire.*—In both oxidizing and reducing flames, yellowish while hot, light green when cold. Free silica undissolved.
11. *Borax, on platinum wire.*—In both oxidizing and reducing flames, yellow while hot, pale amber when cold. Silica not all dissolved.

In all these preliminary tests the mineral closely resembled thorite, except in the permanence of a yellow color in the cold borax bead. The subsequent analysis showed that this was due to the larger amount of uranium present.

A partial preliminary, and a final analysis were made with the following results:

Analysis of Urano-thorite.

Constituents.	Preliminary.	Final.
Moisture and combined water (H_2O)	....	11.31
Silica (SiO_2)	19.43	19.38
Thorium oxide (ThO)	52.51	52.07
Uranium oxide (U_2O_3)	....	9.96
Lead oxide (PbO)	.40	.40*
Aluminium oxide (Al_2O_3)	....	.33
Iron oxide (Fe_2O_3)	....	4.01
Calcium oxide (CaO)	....	2.34
Magnesium oxide (MgO)	....	.04
Sodium oxide (Na_2O)	....	.11
		99.95

* From preliminary analysis.

PLANTS, MEDICINAL AND POISONOUS.

EXAMINATIONS OF VARIOUS "LOCO," OR "CRAZY-WEEDS."

For several years past the department has received numerous letters from correspondents in Colorado, Kansas, California, and other Western States, giving information as to the poisonous action upon horses, cattle, and sheep of various plants popularly known as "loco-weeds," or "crazy-weeds." A considerable number of plants has been received. Those most frequently complained of have been *Oxytropis Lamberti*, *Astragalus mollissimus*, and *Sophora serecia*. In addition, there have also been mentioned, and some samples also have been obtained of, *Oxytropis multiflora*, *Oxytropis deflexa*, *Malvastrum coccineum*, and *Corydalis aurea*, variety *occidentalis*.

The reports from various correspondents and from widely-separated regions agree closely as to the injurious and frequently fatal effect upon animals of eating these "loco-weeds."

The habit of eating these weeds seems to be formed because of the scarcity, at certain seasons, of nutritious grasses. All or nearly all of these plants, except *Oxytropis*, have a bitter, disagreeable taste, yet after the habit has once been formed the animals reject the sweetest grasses. Among the symptoms first noticed are loss of flesh, general lassitude, and impaired vision; later the animal's mind seems to be affected; it becomes often vicious and unmanageable, and flesh and strength are both rapidly lost. When approaching some small object it will often leap into the air as though to clear a high fence. Frequently in these paroxysms horses have died from falling backward.

The time required for these weeds to kill animals varies greatly, some dying within three or four days, others lingering for a year or longer. Some correspondents state that horses seem more susceptible to the influence of these plants than are either cattle or sheep; others report tha all are effected similarly.

There is some difference of opinion as to the real cause of the diseases commonly attributed to "loco." Some think that the animals suffer not so much from direct poisoning as from lack of nutritive food and water. Mention is made of buttermilk as an antidote, but it seems not to have proved valuable.

Mr. Francis A. Wentz, of Kinsley, Kans., has instituted a series of "provings" of the herb and seeds of *Sophora serecia* and the herb of *Astragalus mollissimus;* he hopes during the coming year to establish beyond question what, if any, particular constituents in these plants

are poisonous to domestic animals. This department is indebted to him for much valuable information in regard to the action of these plants. At his request careful chemical examinations have been made of these particular plants; the work here given is as complete as time will allow, but a supplementary report will probably be made during the coming year.

Acknowledgments are also due to L. F. Dyrenforth, J. A. Eddy, and others for samples and information.

BOTANICAL DESCRIPTION OF SOPHORA SERECIA, NUTT.

By the Botanist.

The genus *Sophora* is characterized as follows:

Calyx tube campanulate; teeth short. Petals nearly equal; standard broad. Stamens distinct; anthers uniform, versatile. Style incurved; stigma minute. Pod stipitate, terete, or somewhat compressed, thick, or coriaceous, mostly indehiscent, several seeded, constricted between the obovoid or subglobose seeds, and usually necklace-like. Trees, shrubs, or herbs; leaves unevenly pinnate, with few or many entire, often coriaceous leaflets; stipules small or obsolete; racemes terminal.—(Brewer and Watson in Botany of California.)

The genus belongs to the natural order *Leguminosæ*. It embraces some 25 species found in different parts of the world. In North America we have four shrubby species or some becoming small trees, viz., *Sophora tomentosa*, found on the coast in Florida; *Sophora speciosa* and *Sophora affinis*, found in Western Texas, New Mexico, and Mexico; and *Sophora Arizonica* in Arizona. *Sophora Japonica* is a middle-sized tree of Japan, which is in cultivation in many of our cities, and is quite an ornamental tree.

We have two native herbaceous perennial species, viz., *Sophora stenophylla* and *Sophora serecia*, ranging from Colorado to Mexico and Arizona, the first named seldom reaching to Colorado. *Sophora serecia* is described as follows:

Herbaceous, low, 6 to 12 inches high, more or less silky, canescent; stems ascending or decumbent, branching from the base; leaflets about 21, elliptic or cuneate oval, 2 to 3 lines long; racemes terminal, short, $1\frac{1}{2}$ to 2 inches long, peduncled; calyx gibbous at the base, longer than the pedicels, campanulate, 5-toothed, teeth obtuse, half the length of the tube; corolla 4 lines long, banner reflexed, petals of the keel nearly distinct, acuminate, mucronate.—(Nuttall.)

This species is common on the high plains of Colorado and Nebraska, extending into the lower foot-hills of the Rocky Mountains. The seeds of this species are of a yellowish brown color, of an oblong shape, about one quarter inch in length and half as wide, slightly flattened, with a slender hilum or eye occupying two-thirds the length of the inner face of the seed.

EXAMINATION OF THE HERB OF SOPHORA SERECIA.

Received from Francis A. Wentz, Kinsley, Kans.

A proximate analysis of the plant and roots yielded the following results:

1. Volatile oil	.23
2. Chlorophyl	.50
3. Soft yellow resin	2.99
4. Impure alkaloid	1.37
5. Color and malic acid	1.67
6. Tannic acid	1.22
7. Extractives, soluble in water and 80 per cent. alcohol	9.56

8. Extractives, not redissolved by water and alcohol	1.08
9. Brown hard resin	1.63
10. Albuminoids; total nitrogen × 6.25	14.95
11. Acid extract, containing starch isomers, by difference	15.58
12. Alkali extract, not nitrogenous	4.78
13. Gum and yellowish coloring matter	8.98
14. Crude fibre	19.46
15. Ash, soluble in water, 1.75; soluble in acid, 4.15	5.90
16. Sand	1.41
17. Moisture	8.69
	100.00

The presence of an alkaloid in this plant in appreciable quantity is certain, and the poisonous action upon animals which has been reported is very probably due to the alkaloid chiefly. The following are some of its chemical characteristics:

a. Solubilities.—It is freely soluble in water, hot and cold alcohol, acids, alkalies, and alkaline carbonates. Ether, benzole, and chloroform dissolve it sparingly. Amylic alcohol dissolves it freely.

b. Reactions.—An acid (sulphuric or hydrochloric) solution was precipitated by—

1. Potassic mercuric iodide ("Mayer's reagent"). An abundant yellowish amorphous precipitate; soluble in alcohol; less easily in ether.

2. Phosphomolybdic acid ("Sonneschein's reagent"). An abundant yellowish precipitate; soluble in ammonia to a greenish-blue liquid, which fades on boiling; acidulation with nitric acid causes a precipitate apparently identical with that first formed.

3. Iodine in potassic iodide. A brick-red amorphous precipitate, which becomes nearly black upon standing with excess of iodine solution.

4. Tannic acid (in aqueous solution to which a little alcohol was added). A gray-brown precipitate; somewhat soluble in acetic acid.

5. Chloride of gold. A yellowish, amorphous precipitate.

No precipitates were obtained in acid solutions with platinic chloride or picric acid; neither did picric acid precipitate a simple aqueous solution of the alkaloid.

Since these reactions were recorded, an examination of the seeds of the same plant has afforded opportunity for further investigation of the properties of this alkaloid. Reference is made to the analysis of the seeds.

It is possible, yet hardly probable, that the soft, yellow resin (3) may have some deleterious properties. The "provings" to be made by Mr. Wentz may throw some light upon this point. The other constituents of possibly injurious properties are probably included in "Extractives soluble in water and 80 per cent. alcohol" (7). The chances are, however, largely in favor of the alkaloid being the chief constituent of poisonous properties.

EXAMINATION OF THE SEEDS OF SOPHORA SERECIA.

Received from Francis A. Wentz, Kinsley, Kans.

These seeds have a taste much more persistent and bitter than that of the herb. The following is a proximate analysis:

1. Yellow fixed oil	9.37
2. Alkaloid and red coloring matter	1.74
3. Organic acid (malic) and color	4.45
4. Extractive, soluble in alcohol and water	12.30
5. Extractive, soluble in alcohol, not soluble in water	.83
6. Gum	4.22

7.	Albuminoids (non-alkaloidal nitrogen x 6.25)	18.55
8.	Starch isomers in acid extract	14.36
9.	Extracted by alkali and acid, not starch or nitrogenous	13.46
10.	Pure cellulose	8.67
11.	Lignose and color	1.33
12.	Ash, soluble in water	1.33
	Ash, soluble in acid	1.08
13.	Moisture	8.35
		100.04

These seeds contained no organized starch granules, but, after extraction with naphtha, chloroform, alcohol, and water, they gave an amount of glucose, when boiled with dilute acid, equivalent to 14.36 per cent. of starch. The red coloring matter was present in nearly all the extracts in varying amounts; it seems to be present in the seed coat, and to be somewhat modified in its solubilities by the action of heat and reagents.

The substances of principal interest in this investigation are the *fixed oil* and the *alkaloid*. The malic acid probably exists in combination with the alkaloid.

EXAMINATION OF THE FIXED OIL.

A rather thin fixed oil, of a reddish-yellow color and peculiar odor.

Specific gravity .9255, compared with water at same temperature (20°.5 C).

Reaction neutral to litmus paper.

Soluble in ether, chloroform, petroleum, naphtha, and benzole; sparingly in alcohol.

With nitrous acid no decisive reaction for elaidin.

Concentrated sulphuric acid dropped upon a few drops of the oil causes the following changes of color: Olive-green, chocolate, red-brown, purplish-brown, purple.

Concentrated nitric acid, light-green, quickly changing to light yellowish brown.

Concentrated hydrochloric acid, no apparent change.

A careful determination of the insoluble fatty acids in this oil, by the method of Hebner and Angell, gave 95.62 per cent. The greater portion of these fatty acids seems to be *linoleic acid*, the chief constituent of the fatty acids in linseed oil. This was proven as follows: A portion of the oil was saponified with alcoholic potash, the alcohol evaporated and replaced by water, and the solution thus formed exactly neutralized by acetic acid. A single drop of acetic acid was then added, and the solution precipitated by normal acetate of lead. The precipitated neutral lead soap was once washed by decantation with hot water, carefully drained, and treated with pure ether. Nearly all of the lead soap was dissolved by the ether, the liquid was filtered, and a portion of the filtrate was evaporated to dryness in a tarred dish; .741 gram of the lead soap was carefully ignited with sulphuric acid; .3160 gram of anhydrous lead sulphate was found, equivalent to .2159 gram of metallic lead, or 29.14 per cent. of lead.

	Theory.	Found.
Lead linoleate ($Pb.(C_{16}H_{27}O_2)_2$)	29.20 % Pb.	29.14 % Pb.
Soluble in ether gave		30.02 / 30.14 % Pb.

This oil does not seem to harden upon exposure to the air as readily as does linseed oil.

EXAMINATION OF THE ALKALOID IN THE SEEDS OF SOPHORA SERECIA.

Although abundant chemical evidence was obtained during the progress of the analysis that both herb and seeds contained a considerable amount of a very bitter alkaloid, still its isolation in a pure form was a matter of considerable difficulty. In the seeds it is associated with malic acid and a yellowish-brown substance of active reducing properties. From this latter substance it seemed almost impossible to separate it, but by adopting several expedients it was finally isolated in what seems to be a tolerably pure condition. The methods are given exactly as they were applied. Several operations might be dispensed with in the future, and a much simpler scheme devised, as the outgrowth of the experience gained.

SEPARATION OF THE ALKALOID.

Two hundred and sixty-eight grams of the finely-powdered seeds were percolated with Squibb's ether until apparently exhausted. This ethereal extract contained, when evaporated, the fixed oil, with a little coloring matter. The seeds were then dried and extracted with 94 per cent. alcohol, to which had been added 5 per cent. of acetic acid. When the percolate no longer had a bitter taste the treatment with alcohol was discontinued. The alcohol was evaporated, the residue treated with water and filtered, and the acid filtrate was precipitated by normal acetate of lead. A small amount of a flocculent, flesh-colored precipitate formed, which proved upon investigation to be malate of lead, associated with a little coloring matter. The filtrate from this lead precipitate was treated with sulphuretted hydrogen, filtered, the filtrate concentrated on the steam-bath, with addition toward the end of a faint excess of ammonia. When well concentrated and nearly free from ammonium acetate the liquid was acidified with sulphuric acid and precipitated by excess of potassic mercuric iodide ("Mayer's solution"). An abundant, bulky, amorphous, yellowish-white precipitate was formed. This precipitate was washed on a filter with cold water until the washings became somewhat turbid from dissolved precipitate. It was then suspended in water and treated with sulphuretted hydrogen, filtered from black mercuric sulphide, and the very acid filtrate concentrated to expel all free sulphuretted hydrogen. This liquid was then precipitated by a solution of iodine in potassic iodide. When insufficient iodine was added for complete precipitation of the alkaloid, the precipitate had a brick-red color, but with excess of iodine the precipitate was very nearly black, much resembling free iodine in color. This precipitate was washed with cold water and treated, in presence of water, with moist silver oxide. After slight concentration on the water-bath, the liquid was filtered from the silver iodide and excess of silver oxide. The filtrate was deep wine-red by transmitted light, and by reflected light had a beautiful and strongly-marked yellowish-green fluorescence, which was less evident upon acidulating the liquid with sulphuric or hydrochloric acid.

The solution of the alkaloid was intensely bitter; had a distinctly alkaline reaction, and gave with reagents the following reactions:

1. Hydrates of potash, soda, and ammonia caused no precipitates.
2. Potassic mercuric iodide ("Mayer's solution") caused a bulky, flocculent, yellowish-white precipitate, which dissolved readily in alcohol and less freely in ether.
3. Phosphomolybdic acid ("Sonnenschein's reagent") caused a light-

yellow precipitate, soluble in ammonia to a greenish-blue solution; boiling gradually dissipated the color until it was nearly destroyed, the meniscus having a lemon-yellow color, and the liquid a very pale amber. Addition of excess of nitric acid to this liquid caused an abundant, flocculent precipitate rather more yellow than before.

4. Iodine in potassic iodide causes a brick-red precipitate, darkened in color by excess of iodine.

5. Picric acid (in alcoholic solution) causes no precipitation.

6. Infusion of galls, containing alcohol, causes a grayish-red precipitate, pretty freely soluble in acetic acid and dilute sulphuric and hydrochloric acids.

7. Gold chloride, with free hydrochloric acid, causes a flocculent lemon-yellow precipitate; .1336 grams of this precipitate, previously well washed with water and dried at 85° C., left upon ignition .0460 of metallic gold, equivalent to 34.43 per cent. A previously-formed precipitate, of the purity of which there is more doubt, contained 31.83 per cent. of gold.

8. Platinic chloride causes the slow separation of a yellowish precipitate which has not been further examined; in hydrochloric solutions no precipitate is formed.

9. The alkaline solution was shaken with solvents insoluble in water; ether, benzole, and chloroform removed small amounts of the alkaloid only, while amylic alcohol removed it freely.

By comparing these reactions with those recorded for the alkaloid in the herb of this plant, it will be seen that they are identical.

The remainder of this alkaline liquid was neutralized with sulphuric acid, evaporated and dissolved in absolute alcohol. This liquid was percolated through purified animal charcoal, which removed all the alkaloidal sulphate. After washing the charcoal with cold absolute alcohol, it was treated with hot absolute alcohol, whereby the alkaloid was removed as a neutral sulphate. This, when evaporated, left a red-brown, neutral, very hygroscopic residue of exceedingly bitter taste. This residue gave positive tests both for sulphuric acid and nitrogen. Hence it is asserted that the plant and seeds of *Sophora serecia* contain a bitter alkaloid. In addition to the precipitations caused by the general alkaloid reagents, the following special reactions were obtained by treating the solid sulphate:

1. Concentrated sulphuric acid, cold and warmed, gave a yellowish-brown color, becoming chocolate-brown on standing.

2. Concentrated sulphuric acid with potassic bichromate, a prompt green coloration, due to reduction of the chromic acid to chromic salt; on long standing the color became olive-green.

3. Concentrated nitric acid caused a lemon-yellow color, which became a little darker upon adding excess of ammonia; the same colors with sulphuric acid and potassic nitrate, and with nitric acid, followed by hydrochloric acid.

4. Sulphuric acid, containing ammonic molybdate ("Frœde's reagent"), cold, yellowish; warmed, becomes successively greenish, green-blue, and finally deep indigo-blue.

5. Ferric chloride (aqueous) gives an orange coloration with the solid alkaloid sulphate.

6. Potassic ferricyanide, warmed in aqueous solution with the alkaloid sulphate, becomes greenish, and contains ferrocyanide.

7. Potassic permanganate in aqueous solution is reduced with precipitation of brown manganese oxides.

8. Evaporated and warmed with zinc chloride a brown to amber color

appears. From the reactions with bichromate (2), ferricyanide (6), and permanganate (7), it appears that this alkaloid is an active reducing agent.

It seems very probable that this alkaloid is identical with the *Sophoria* discovered by H. C. Wood, jr., in the seeds of *Sophora speciosa*. In fact, a physiological experiment upon a kitten gave exactly the same indications as are recorded by H. C. Wood, jr., in the American Journal of Pharmacy, January, 1878, page 34, and in the Philadelphia Medical Times, August 4, 1877.

In a single experiment made here the following symptoms were observed: To a half-grown kitten was given an extract from the seeds containing not over one-fourth grain of the alkaloid. Except excessive frothing, no decided effect was noticed until fifteen minutes had passed; then a slight spasmodic twitching of the lower extremities was noticed. This continued about half an hour, when a second dose of the same amount was administered. This increased the number and frequency of the twitchings, and after a few minutes' vomiting occurred, followed by partial stupor and a general nervous twitching of the whole body; there seemed to be no effect upon the mind, and no delirium at any time. Lack of material prevented further experimentation, and the cat recovered fully in a couple of hours.

It is hoped that a more complete chemical and physiological investigation may be made during the coming year; any results will appear in the next annual report. It is hardly to be doubted that the alleged poisonous effects of this plant are due largely or entirely to this alkaloid; at the same time it is not improbable that some medicinal uses may be discovered which will fully compensate for the labor of analysis, if not for the loss of cattle already incurred by our western farmers.

PRELIMINARY REPORT ON THE HERB OF ASTRAGALUS MOLLISSIMUS.

Received from Francis A. Wentz, Kinsley, Kans.

A proximate analysis showed the following constituents:

1. Moisture	12.28
2. Ash	6.76
3. White wax	1.30
4. Chlorophyl and fatty substance	1.23
5. Neutral resins *a*	1.67
6. Neutral resins *b*	.42
7. Acid resins *c*	.60
8. Organic acid and color	3.77
9. Bitter extractive *	7.89
10. Gum	4.04
11. Albuminoids	15.59
12. Tannic acid, iron greening	2.41
13. Starch isomers	6.77
14. Acid and alkali extracts, not starch or nitrogenous, difference	11.89
15. Crude fiber	23.38
	100.00

The only substances likely to prove poisonous in this plant are the alkaloid and bitter extractive (No. 9). If facilities can be had a large amount of this plant will be treated, and the alkaloid extracted

* Some reactions lately obtained point to the probable presence of a very small amount of an alkaloid. This alkaloid seems to be sparingly soluble in water. The reactions observed would indicate less than ½ per cent. in the plant.

and examined. The means at present supplied by Congress are entirely inadequate. It is hoped also that the provings instituted by Mr. Wentz may be ready for report in the next annual report of this department.

PRELIMINARY REPORT ON THE HERB OF OXYTROPIS LAMBERTI.

Received from L. F. Dyrenforth, Chicago, Ill.

The following is a proximate analysis:

1. Moisture		6.70
2. Ash, soluble in water	1.06	
Ash, soluble in acids	2.89	
Ash, combined silica	.37	
		4.32
3. Sand		3.12
4. Chlorophyl, wax, resin, trace organic acid		4.36
5. Tannin, iron greening		1.90
6. Glucose		1.61
7. Sucrose		1.31
8. Resin, insoluble in ether		.54
9. Extractive (not bitter) and color		6.16
10. Gum		3.90
11. Starch isomers		9.61
12. Substances, not nitrogenous, extracted by acid and alkali		20.64
13. Albuminoids		10.85
14. Cellulose		24.66
		99.68

Water removes from an alcoholic extract of this plant a number of substances (Nos. 5, 6, 7, 9), which, taken together, have a sweet, not unpleasant taste, which may account for the preference shown by animals for this weed over the various grasses which grow with it. The extractive (No. 9) seems to contain a very small amount of an alkaloid, agreeing, so far as examined, with the one present in *Astragalus mollissimus*. Miss Catharine M. Watson,* in 1876, examined this alkaloid of *Oxytropis Lamberti* and reported it to be a brownish, waxy substance, sparingly soluble in water, readily dissolved by dilute acids, and readily soluble in alcohol, chloroform, and ether. "Its ethereal solution had a disagreeable odor, a yellow color, and a deep-blue fluorescence." Its solution in dilute acids "gave precipitates with potassic mercuric iodide, metatungstic acid, phosphomolybdic acid, and solution of iodine in iodide of potassium." For full particulars see the original paper. Some physiological experiments then made led to the conclusion that the "dried ground *root* possesses no poisonous properties."

From the additional work done at this department it seems probable that the deleterious effects observed from animals eating this plant may be due principally to the fact that the sweet taste causes cattle to reject more nutritious food, and strive to subsist upon the *Oxytropis* only. This plant is mechanically a very unfit substance for food, being of a tough, fibrous, and indigestible character. It is possible that, when the animal becomes somewhat enfeebled by lack of proper nourishment, the small amount of alkaloid may have a direct poisonous action. Again, it seems probable that the plant may contain much larger proportions of alkaloid at certain stages in its development than at others, or the seeds may prove to be the most injurious portion.

Much light might be thrown upon this subject by the observations of

*Amer. Journal of Pharmacy, December, 1878, p. 565.

a properly constituted commission, which should visit the localities where the loss of animals has been greatest, inquire thoroughly into the matter, and gather specimens at different stages of development for analysis. The sum necessary for this investigation would be small in comparison with the benefits to be derived.

EXAMINATION OF MALVASTRUM COCCINEUM.

Received from Francis A. Wintz, Kinsley, Kansas.

Moisture			9.737
Ash, soluble in water		3.344	
Ash, soluble in acid		5.263	
Ash, insoluble in acid		2.270	
			10.877
Ether extract:			
a. Insoluble in gasoline:			
Tannin	.354		
White wax	.114		
Chlorophyl	.158		
		.626	
b. Soluble in gasoline:			
Resin *a*	1.496		
Resin *b*	1.484		
Soft fat	1.506		
Volatile oil and loss	.050		
		4.536	
			5.162
80 per cent. Alchol extract:			
a. Soluble in water:			
Tannin, sugars and extractives		8.500	
b. Insoluble in water:			
Resin *c* and color		1.114	
			9.614
Water extract:			
Gum			8.260
Acid extract, starch isomers by titration			16.320
Alkali extract, by difference			15.947
Albuminoids, total nitrogen × 6.25			12.513
Crude fiber			11.570
			100.000

This plant contained no alkaloid nor any bitter substance; the only possibly poisonous substances are the resins, and the chances are not greatly in favor of their being injurious.

It seems very doubtful whether this herb is at all poisonous in the dried condition; possibly drying may render it thus inert.

THE IMPORTANCE OF CAREFULLY SELECTED SEED.

In the report of this department for 1878, page 121 and following, are presented for consideration under the above heading some facts, with the promise that in a future report the result of some field experiments bearing upon the same subject would be given.

A summary of the results given in the report for 1878 is here given for convenience. The seeds taken for this purpose were such as, from their size, could readily be picked over one by one, and comprised the following: three specimens each of maize, pease, and beans.

These seeds were taken from the stores in the department, and there is no doubt that the percentage of vitality was almost, if not quite, 100.

One quart of each variety was taken, and by careful picking was divided into thirds, as follows: first, the best third was selected, then the poorest half of the remainder, and the middle third remained.

Upon weighing a given bulk (one-quarter liter) of the best and poorest thirds, there were found but slight differences in weight, showing

that really the seed was all good and full weight. The average ratio of best to poorest thirds by weight was 100 : 98.56.

In no case was the difference very marked, although in every case but two it was in favor of the best thirds. These exceptions doubtless arose from the large size of these seeds, which prevented their being closely packed in so small a vessel as that in which they were weighed out.

Next, 50 grams of each sample were weighed out, and the number of seeds present in this weight counted out, when the average ratio of the weight of individual seeds was ascertained to be 100 : 71.33.

An examination of several other samples of maize, pease, and beans showed the difference above observed to be pretty constant, *e. g.*, the ratio of weight between an equal number of grains from the first and third thirds of nine samples of maize was 100 : 60; in six samples of pease, 100 : 69; in five samples of beans, 100 : 64; or an average of 100 : 63.7. But another consideration remained, of equal importance with this quantitative difference in the food supply, viz., whether there existed also a qualitative difference; and for the purpose of determining this point complete proximate and ash analyses were made of several of the seeds mentioned, the results of which showed that of each proximate constituent the amount present in the individual seed of each poorest third was about 71.4 per cent. of the amount present in the single seed of the best thirds.

In the same manner, by comparing the full analyses given of the ashes of the several samples, it was found that those two constituents which are most important, and which are present in greatest quantity, viz., potash and phosphoric acid, stand in the same ratio as the organic proximate constituents, *i. e.*, the amount of potash and phosphoric acid present in a single seed of the poorest third of either of these samples analyzed averages exactly 71 per cent. of the amount present in a seed from the best third.

The conclusion, then, from these results is that the young plant would receive from the better seed the same kind of food for its early development, and about 40 per cent. more of it than from the poorest seed. It is also shown that the entire amount of the several seeds submitted to analysis were mature seeds, as, indeed, to the eye they appeared to be different only in their relative size.

When we consider that during the period of germination and the earlier stages of its growth, until in fact through well developed foliage and rootlets the plant is able to appropriate and assimilate food from the atmosphere and earth, its entire supply of nutriment is derived solely from that stored up in the seed, the importance of the above difference in the amount of that supply of food is manifest.

It is not improbable that during the early life of the new plant there may result a feeble struggle for existence, during which period, if not supplied with sufficient and proper food, the plant becomes dwarfed in its full development, with its power of reproduction impaired, and every vital function in marked contrast with that plant which has in its early life received a more generous supply of food.

It is obviously true, and has been proved so by experiment, that even under-sized seed may, in fertile ground, produce well-developed plants; and, indeed, it appears to have been demonstrated that "the vigorous development of plants depends far less upon the size and weight of the seed than upon the depth to which it is covered with earth, and upon the stores of nourishment which it finds in its first period of life," but there still appears to remain, as an open question of very great practical

importance, the comparative value of fully developed and imperfectly developed seed, under the ordinary condition of moisture, fertility, &c.

For the purpose of experiment in the field there were selected 32 seeds of the best and poorest thirds of 15 varieties of maize, 50 seeds each of 5 varieties of beans, and 100 seeds each of 6 varieties of pease.

The weights of each lot were taken and were as follows:

	Best third.	Poorest third.
	Grams.	*Grams.*
15 varieties maize, 480 seeds	156.7	100.9
5 varieties beans, 250 seeds	131.4	82.8
6 varieties pease, 600 seeds	162.3	111.9

The above weights are in the following ratio:

Maize, best to poorest as	100 : 64.39
Beans, best to poorest as	100 : 63.01
Pease, best to poorest as	100 : 68.95

Below is given a tabulated result of the experiment, although, owing to the protracted drought of the past season, little value can be placed upon the results other than as to the percentage of seeds which germinated and the percentage of plants obtained, for it was found that many of the plants which developed partially failed to survive, and, especially in the case of the pease and beans, the crops reported below were obtained as the result of a new growth ensuing after the late rains.

It is also to be borne in mind that these experiments were conducted upon land which, although originally quite unproductive, has been brought by careful cultivation to a high condition of fertility, as may be evidenced by the following analysis:

Analysis of soil of experimental plot.

	Per cent.
Moisture	1.740
Organic matter	4.980
Carbonic acid (CO_2)	.200
Insoluble matter	84.235
Ferric Oxide (Fe_2O_3)	2.864
Alumnia (Al_2O_3)	4.416
Lime (CaO)	.635
Magnesia (MgO)	.400
Potassa (K_2O)	.100
Soda (Na_2O)	.054
Phosphoric acid (P_2O_5)	.198
Sulphuric acid (SO_3)	.024
	99.846

Obviously, upon land of such composition and deep tilth the plant would find every needed element for its nutrition, and the experiments, before being accepted as conclusive upon other points than those mentioned, should be repeated upon other soils not so well adapted to the development of the plant after germination.

Average per cent. plants from seed:

6 pease: 1st 3d, 60.5 per cent.; 3d 3d, 65.2 per cent.
5 beans: 1st 3d, 88.0 per cent.; 3d 3d, 70.8 per cent.
8 corn: 1st 3d, 53.1 per cent.; 3d 3d, 49.3 per cent.
7 corn: 1st 3d, 32.0 per cent.; 3d 3d, 19.4 per cent.

Average per cent. seed sprouted:

6 pease: 1st 3d, 61.7 per cent.; 3d 3d, 66.7 per cent.
5 beans: 1st 3d, 94.4 per cent.; 3d 3d, 73.2 per cent.
8 corn: 1st 3d, 58.0 per cent.; 3d 3d, 55.8 per cent.
7 corn: 1st 3d, 49.6 per cent.; 3d 3d, 34.3 per cent.

Average weight of crop to plant:
6 pease: 1st 3d, 3.76 grams; 3d 3d, 4.09 grams.
5 beans: 1st 3d, 100.9 grams; 3d 3d, 155.6 grams.
8 corn: 1st 3d, 77.3 grams; 3d 3d, 97.4 grams.
7 corn: 1st 3d, 53.4 grams; 3d 3d, 21.3 grams.
Average weight of entire crop:
6 pease: 1st 3d, 241.0 grams; 3d 3d, 283.5 grams.
5 beans: 1st 3d, 503.2 grams; 3d 3d, 614.8 grams.
8 corn: 1st 3d, 1568.6 grams; 3d 3d, 1679.9 grams.
7 corn: 1st 3d, 588.7 grams; 3d 3d, 161.6 grams.
Total average per cent. plants from seed: 1st 3d, 55.8 per cent.; 3d 3d, 49.1 per cent.
Total average per cent. seeds sprouted: 1st 3d, 63.6 per cent.; 3d 3d, 55.9 per cent.
Total average weight of crop to plant: 1st 3d, 58.4 grams; 3d 3d, 66.6 grams.
Total average weight of entire crop: 1st 3d, 793.5 grams; 3d 3d, 744.1 grams.

As will be seen from the above, the percentage of seed which sprouted was generally higher in the case of the best thirds, but was in no case so high as the character of seed used appeared to warrant. In fact all the seed used appeared to possess vitality, and the results obtained by experiment were doubtless due to the unfavorable conditions after the planting, by which the seed was destroyed.

As will be seen from the analyses, the composition of the best and poorest thirds of seed used in these experiments was about identical, and the only difference between the individual seeds from the best and poorest thirds was a quantitative one, which the character of the soil and season made of no account.

But although the above experiments fail to be conclusive, or indeed of value as an element in settling the main question proposed, the following results obtained in England in 1877 with oats are most important. The analyses given are by Prof. Henry Tanner.

Constituents.	Composition of—	
	Heaviest oats.*	Lightest oats.†
Gluten	8.92	2.72
Starch, gum, &c	61.17	64.20
Fatty matter	2.33	3.92
Cellulose	11.83	12.98
Nitrogenous matter (not true albuminoids)	.84	.50
Alkaline salts in ash	.75	.50
Earthy salts in ash	1.07	1.32
Silicious matter in ash	.70	.90
Water	12.34	12.96
	100.00	100.00

Constituents.	Composition of crop.	
	Under good cultivation.‡	Under bad cultivation.§
Gluten	7.18	1.58
Starch, gum, &c	61.69	64.49
Fatty matter	2.88	1.68
Cellulose	9.10	16.36
Nitrogenous matter (not true albuminoids)	3.32	1.21
Alkaline salts in ash	1.20	1.05
Earthy salts in ash	.58	.82
Silicious matter in ash	.70	.88
Water	13.35	11.93
	100.00	100.00

*Forty-nine pounds per bushel.
†Twenty pounds per bushel.
‡Fifty bushels per acre, weighing 43 pounds per bushel.
§ Ten bushels per acre, weighing 22 pounds per bushel.

Constituents.	Composition of oats grown from seed—	
	Of good character.	Of bad character.
Gluten	5.89	2.72
Starch, gum, &c	62.94	64.20
Fatty matter	2.81	3.92
Cellulose	11.70	12.98
Nitrogenous matter (not true albuminoids)	1.18	.50
Alkaline salts in ash	.07	.50
Earthy salts in ash	.57	1.32
Silicious matter in ash	1.98	.90
Water	12.86	12.96
	100.00	100.00

GRAINS.

The value to the farmer of various grains, as deduced from chemical analysis.

The reports of the statistician for the past ten years (1870–1879) show the following average values *to the farmer* of the principal agricultural food materials:

TABLE A.

Varieties.	Value per bushel.	Value per 100 pounds.
Corn	0.4397	0.78
Wheat	1.0635	1.77
Rye	.7200	1.29
Oats	.3649	1.14
Barley	.7508	1.56
Buckwheat	.7111	1.42
Potatoes	.5814	.97
Hay, per ton of 2,000 pounds	12.8581	.65

Average value per 100 pounds for grains, $1.327; average value per 100 pounds for all, $1.200.

The substances which give these foods value may be divided into three classes:

1. *Albuminoids:* Nitrogenous compounds which serve as "flesh-formers."

2. *Fats:* Solid or liquid oils.

3. *Carbhydrates*, or "nitrogen free extract": starch, sugar, gum, &c. These, with the fats, are sometimes known as "heat or force givers."

The comparative value of these three classes as foods has been approximately determined by a commission appointed by the German agricultural experimental stations. These results are reported by Kœnig,* the chairman of the commission, and are as follows:

TABLE B.—*Proportionate values nutritive constituents in food materials.*

Albuminoids	34.6	=	4.74
Fat	29.8	=	4.08
Carbhydrates	7.3	=	1.00

Having these proportionate values, we find that on an average specimen the value of our cereals is subdivided thus:

* "Berechnung des Geldwerthes von Futtermitteln," in die Landwirthschaftlichen Versuchs-Stationen, Band xxiv, p. 302.

TABLE C.—*Value of each constituent in an average grain.*

Constituents.	Value per 100 pounds.	Value in each dollar.
	Cents.	*Cents.*
Albuminoids	49.842	37.56
Fat	13.668	10.30
Carbhydrates	69.190	52.14
	132.700	100.00

If, then, we know the number of pounds of each of these constituents in a hundred-weight of an "average grain," we can find the value of each per pound by dividing the value in cents per hundred-weight by the pounds per hundred-weight.

It remains, therefore, to determine as accurately as possible the average content of American cereals in these substances that give them their food value, the "nutrients," viz: albuminoids, fat, and carbhydrates.

The following averages have been drawn from the most reliable recorded American analyses. The most of them have been taken from the valuable "Report of the Connecticut Agricultural Experiment Station," for 1879, which contains all the later American analyses from various sources. The average figures for rice are taken from the results of analyses this year, made at this department, of ten varieties sold in American markets.

TABLE D.—*Average nutrients in American grains.*

Variety.	Albuminoids.	Carbhydrates.	Fat.	Total nutrients.
Flint corn	10.70	70.19	5.16	86.05
Dent corn	10.49	70.20	4.84	85.53
Sweet corn	12.08	67.37	8.04	87.49
Winter wheat	10.17	75.73	2.23	88.13
Spring wheat	12.41	73.18	2.39	87.98
Rye	12.07	73.91	2.07	88.05
Barley	13.17	72.96	3.15	89.28
Rice	7.44	79.20	.35	86.99
Average	11.07	72.84	3.53	87.44

The figures above used for rye and barley will probably be slightly changed when more analyses have been made. Buckwheat was not included in this list for lack of authenticated analyses of American samples. It is pretty certain, however, that its composition does not vary greatly from the above average. Oats were not included, because of their much greater amount of fiber, which proportionately reduces the amount of nutrients.

TABLE E.—*Average nutrients in an "average grain."*

Constituents.	I.—Pounds in 100.	II.—Value in 100 pounds.	III.—Value per pound.
		Cents.	*Cents.*
Albuminoids	11.07	49.842	4.5024
Fat	3.53	13.668	3.8436
Carbhydrates	72.84	69.190	.9499
Total nutrients	87.44	132.700	....

The values in column III are found by dividing the figures in column II by those in column I. Reduced to more simple forms, they are as follows:

TABLE F.—*Value per pound of nutrients in American grains.*

	Cents.
Albuminoids	4.50
Fat	3.84
Carbhydrates	.95

Having, then, the analysis of a grain, its value *to the farmer* can be found by multiplying the percentages respectively of albuminoids, fat, and carbhydrates by the above figures. The average values of these grains have thus been calculated, and are as follows:

TABLE G.—*Average value, per* 100 *pounds, to the farmer, of various grains.*

Varieties.	Albuminoids.	Fat.	Carbhydrates.	Total.
	Cents.	*Cents.*	*Cents.*	*Cents.*
Flint corn	48.15	19.81	66.68	134.64
Dent corn	47.21	18.59	66.69	132.49
Sweet corn	54.36	30.87	64.00	149.23
Winter wheat	45.77	8.56	71.94	126.27
Spring wheat	55.85	9.18	69.52	134.55
Rye	54.32	7.95	70.21	132.48
Barley	59.27	12.10	69.31	140.68
Rice	33.48	1.34	75.24	110.06

It will be noticed that some marked differences in value are seen in comparing this table with Table A. This must necessarily be the case, as will be seen by reference to the following table:

TABLE H.—*Percentage exported of agricultural food products.*

Varieties.	Production in 1878.	Exports to June 30, 1879.	Per cent. exported.
Corn ... bushels	1,388,218,750	88,262,052	6.4
Wheat ... do	420,122,400	150,502,506	35.8
Rye ... do	25,[illegible]	4,8[illegible],470	18.9
Oats ... do	413,578,560	5,452,136	1.3
Barley ... do	42,245,630	715,536	1.7
Buckwheat ... do	12,246,820	None.	....
Potatoes ... do	124,126,650	625,342	.5
Hay ... tons	39,608,296	8,127	.02

Careful study of this table, together with Tables A and G, will explain some apparent discrepancies. Among other facts we shall see—

1. That a production in great excess of foreign and actual home demands will cause the market value to fall far below the actual value to the farmer. This is very noticeable in the case of corn.

2. A large foreign demand, together with a similar home demand, coupled with no overproduction, will cause the market price to be higher than the real value to the farmer. This is illustrated by the cash value of wheat.

3. A production about equal to the demand will cause the value to the farmer and the market value to correspond quite closely. Oats, buckwheat, and rye are instances. Barley brings a little more, owing

to its extensive use in brewing and to its cultivation being more localized than is the case with other grains.

4. In the case of rice, the market value is entirely disproportionate to its cash value as a food to the consumer. Among the causes to which this discrepancy is due may be mentioned the following:

a. The uncertainty as to production, and the danger that unfavorable seasons may cause greatly diminished crops.

b. The comparatively small area in this country devoted to its cultivation; and the expense entailed by the long and risky sea voyage, if it be imported from India.

c. The expense of preparing it for the market.

d. The fact that the number of wholesale dealers is small, thus depriving consumers of the benefits of competition.

e. The principal reason, however, seems to be that it is not here regarded as one of our *staple foods*, but rather as an accessory to be used occasionally.

5. By no means all the circumstances affecting the market values have been mentioned; merely those which most evidently cause the selling price to vary from the value as deduced from analysis. It will plainly be seen that the farmer can best afford to sell those grains which have a market value above their value as shown by analysis; thus, at present prices, corn is worth as a food nearly twice what it brings in the market, while wheat and barley are worth less.

These remarks will explain how values are deduced from analyses, and the weight that should be given to the prices so obtained.

ANALYSES OF IMMATURE SWEET CORN AND COBS.

The ears were selected when the corn was "in the milk" and in the best condition for table use. The corn and cob were carefully separated, partially dried, pulverized, and analyzed.

The following are the results obtained:

Constituents.	Adam's early corn.		Mammoth sugar-corn.	
	Air-dry.	Dry.	Air-dry.	Dry.
Moisture	8.42	....	11.24	....
Ash	3.09	3.37	2.95	3.32
Cellulose	3.10	3.39	3.07	3.46
Oils	4.18	4.56	5.32	5.99
Sugars, &c.*	8.84	9.66	8.08	9.10
[illegible]	6.06	6.63	6.27	7.06
Albumen	9.52	10.41	8.26	9.31
Gum	.72	.79	†2.95	†3.32
Starch†	56.07	61.19	51.86	58.44
	100.00	100.00	100.00	100.00

*Estimated by difference. Soluble in 80 per cent. alcohol and soluble in water.

†Includes [illegible] soluble starch, which was not present in Adam's early corn. Soluble starch appears to be formed from ordinary insoluble starch during the ripening of the grain of sweet corn; it is not present in ripened field corn. (*See* Agricultural Department Report for 1878, pp. 153-155.)

Analysis of sweet-corn cobs.

Constituents.	Adam's early cobs.		Mammoth sugar cobs.	
	Air-dry.	Dry.	Air-dry.	Dry.
Moisture	12.40	....	7.51	....
Ash	2.45	2.80	2.28	2.47
Cellulose	22.74	25.96	18.18	19.66
Oils	1.84	2.10	1.62	1.75
Sugars, &c*	13.28	15.16	12.68	13.71
Zein	2.75	3.14	1.50	1.62
Albumen	2.68	3.06	3.75	4.05
Gum	1.10	1.25	.96	1.04
Starch isomers†	25.01	28.55	27.95	30.22
Alkali extract‡	15.75	17.98	23.57	25.48
	100.00	100.00	100.00	100.00

In order that a general idea may be had, at a glance, of the probable food value for animals of sweet corn and the cobs from which it is taken, the substances usually considered to have equal food value will be grouped together.

These substances are, in the corn itself—

1. Albuminoids, including zein and albumen.
2. Carbhydrates, including sugars, gum, and starch.
3. Oils, commonly called "fats."

In the corn-cobs—

1. Albuminoids, zein, and albumen, as in corn itself.
2. Carbhydrates, sugars, gum, starch-isomers, and alkali extract.
3. Oils, as in corn.

All comparisons are on dry samples.

Digestible nutrients in sweet corn and cobs.

Constituents.	Corn.		Cobs.	
	Adam's early.	Mammoth sugar.	Adam's early.	Mammoth sugar.
Albuminoids	17.04	16.37	6.20	5.67
Carbhydrates	71.64	70.86	62.94	70.45
Fat	4.56	5.99	2.10	1.75
Nutritive ratio§	1:4.5	1:4.7	1:10.5	1:12.7
Calculated value per hundred pounds on dry substance	1.62	1.64	.96	.99
Calculated value per hundred pounds on air-dry substances	1.49	1.46	.84	.92

In absence of proof as to the value of "alkali extract" in corn-cobs, it has seemed best to give a calculation in which it is not included. The value of "starch-isomers" would seem to be less doubtful, as they are

*Estimated by difference.

†Soluble in 80 per cent. alcohol and soluble in water.

‡After extracting with ether, alcohol, and water, the sample was treated at 100° C. for about six hours with dilute hydrochloric acid; glucose was determined in this acid liquid, and the amount found calculated to its starch equivalent ($C_6H_{10}O_5$). These "starch isomers" are identical with the "amylaceous cellulose" described in the Department of Agriculture Report, 1878, pp. 188-191.

§By nutritive ratio is meant the proportion of nitrogenous to non-nitrogenous nutrients.

converted into glucose with almost or quite the same readiness as is starch itself.

Probable value of immature corn-cobs, exclusive of "alkali extract."

Values.	Adam's early cobs.	Mammoth sugar cobs.
Value per 100 pounds on dry substance	.79	.75
Value per 100 pounds on air-dry substance	.69	.70

The proportion of cob to corn is probably considerably greater in the immature state than when the corn has ripened, hence the real proportionate value of the cob to the corn is probably greater at this period than it is later.

In whatever light these results may be viewed, it still seems that immature corn-cobs have a decided food-value and can profitably be fed to stock. By reference to the department report for 1878, p. 136, it will be seen that the value of mature corn-cobs from field-corn, even when "alkali extract" is included, is about 57 cents per hundred pounds, or considerably less than the value of immature cobs from sweet corn *exclusive* of alkali extract.

In Table G the value of mature sweet corn is given at $1.49, a figure nearly identical with those deduced for air-dry immature sweet corn.

Analyses of Fultz wheat.

Constituents.	No. 1.—Entire wheat.	No. 2.—Wheat freed from bran.	No. 3.—Bran.
Moisture	10.40	10.60	8.93
Ash	1.15	1.45	2.52
Oil	2.45	2.27	1.72
Sugars, &c	3.61*	2.88	5.42*
Gluten	3.94	4.05	.55
Gum	1.54	1.14	.86
Starch or isomers	67.24	68.46	59.00
Albumen	7.96	8.01	5.99
Fiber	1.71	1.14	15.01
	100.00	100.00	100.00

The valuable constituents in these three samples are:

1. *Albuminoids*, gluten and albumen.
2. *Fat*, or oil.
3. Carbhydrates, including sugars, gum, and starch, and starch-isomers in the bran.

Calculated comparative food-values.

Values per 100 pounds:	
Entire wheat	$1 32
Wheat freed from bran	1 32
Bran	98

The somewhat prevalent idea that bran is the most valuable portion of wheat is not substantiated by these figures drawn from analyses.

* Contains some nitrogenous matter soluble in water, rather more in No. 3 than in No. 1, and absent in No. 2; hence it must be derived from the bran.

The considerably greater proportion of ash in the bran is noticeable. As this ash is largely composed of phosphates, the separation of the bran from flour renders it less rich in these ash constituents, which are believed to be valuable as material for the formation of bones.

Analyses of seeds of sorghum, Chinese Corn, and Brown Doura.

Constituents.	Sorghum seeds.			
	Early amber.	Chinese.	Brown doura.	Chinese corn.
Moisture	10.57	9.93	7.62	7.87
Ash	1.81	1.47	1.68	1.46
Fat	4.60	3.95	4.18	3.75
Sugars	1.91	2.70	2.30	2.06
Albumen, insoluble in alcohol	2.64	2.64	3.00	4.22
Albumen, soluble in alcohol	7.34	6.90	6.01	5.41
Gum	1.10	.72	1.50	2.85
Starch, color, &c	68.55	70.17	72.19	70,59
Crude fiber	1.48	1.52	1.52	1.79
	100.00	100.00	100.00	100.00

The calculated values to the farmer of these seeds per one hundred pounds are here given:

Early amber sorghum seeds	$1 31
Chinese sorghum seeds	1 28
Brown doura seeds	1 29
Chinese corn seeds	1 29

From these results it will be seen that these seeds are very nearly equal in value as food materials to average field corn. In case sorghum is largely grown as a sugar-producing plant, the use of the seeds as food for animals will tend to cheapen the production of sugar.

ANALYSES OF TEN SAMPLES OF RICE AND ONE SAMPLE OF RICE-WASTE.

The samples analyzed were received from Dan. Talmage's Sons & Co., 41 and 43 North Peters street, New Orleans, La.

They were carefully selected and well cleaned, and represent all the marketable varieties to be met with in this country. The rice-waste is understood to be the unmarketable portion separated mechanically from the crude rice; it seems probable that it may be profitably utilized for the manufacture of starch or glucose.

Proximate analyses of rice and rice-waste.

	Oil.	Sugar.	Gum.	Non-nitrogenous substance, not sugar, soluble in water and 80 per cent. alcohol.	Starch, by difference.	Cellulose.	Albuminoid substance soluble in 80 per cent alcohol. Insoluble in water.	Other albuminoids.	Ash.	Water.	Book number.
I.—*In air-dry condition.*											
Carolina gold seed	0.27	......	1.57	0.73	75.40	0.17	0.35	8.20	0.38	12.93	103
Carolina white seed	0.30	......	1.57	0.57	75.47	0.13	0.48	7.83	0.34	13.31	104
Japan, fully cleaned	0.28	......	1.85	0.93	77.45	0.11	0.39	5.47	0.43	13.09	105
Japan	0.42	......	1.74	0.89	74.90	0.17	0.43	7.01	0.42	14.02	107
Patna, Bengal	0.32	......	1.36	0.57	76.71	0.14	0.60	7.10	0.35	12.85	108
Rangoon	0.39	......	1.27	0.72	78.29	0.19	0.27	7.08	0.34	11.45	109
Bassein, F. India	0.62	......	1.05	0.72	77.16	0.19	0.21	8.19	0.48	11.38	110
White seed, Louisiana	0.27	......	1.44	0.79	78.17	0.19	0.24	6.41	0.33	12.16	170
Honduras, Louisiana	0.30	......	1.07	0.77	78.27	0.19	0.24	7.02	0.34	11.80	171
Volunteer, Louisiana	0.37	......	1.35	0.80	78.40	0.40	0.17	6.66	0.40	11.45	172
Rice-waste	7.28	1.92*	3.52	3.65	55.42	3.29	1.00	8.63	6.06	9.23	......
II.—*Dried at 105° C., water-free.*											
Carolina gold seed	0.31	......	1.80	0.84	86.60	0.19	0.40	9.42	0.44	....	103
Carolina white seed	0.35	......	1.81	0.66	87.06	0.15	0.55	9.03	0.39	....	104
Japan, fully cleaned	0.32	......	2.13	1.07	89.11	0.12	0.45	6.30	0.50	....	105
Japan	0.49	......	2.02	1.04	87.11	0.20	0.50	8.15	0.49	....	107
Patna, Bengal	0.37	......	1.56	0.65	88.02	0.16	0.69	8.15	0.40	....	108
Rangoon	0.44	......	1.44	0.81	88.41	0.21	0.30	8.00	0.39	....	109
Bassein, F. India	0.70	......	1.19	0.81	87.08	0.21	0.23	9.24	0.54	....	110
White seed, Louisiana	0.31	......	1.64	0.90	88.98	0.22	0.27	7.30	0.38	....	170
Honduras, Louisiana	0.34	......	1.20	0.88	88.74	0.22	0.27	7.96	0.39	....	171
Volunteer, Louisiana	0.42	......	1.53	0.90	88.53	0.45	0,19	7.53	0.45	....	172
Rice-waste	8.02	2.10*	3.88	4.02*	61.06	3.63	1.10	9.51	6.68	....	......

* A solution of the "waste" which would have contained the *sugar* had any been present, did not give a reaction for *glucose*, but upon being digested with dilute acid, it reduced Fehling's solution of cupric oxide in a ratio equivalent to 1.92 per cent. of sucrose in the air-dry material, or 2.10 per cent. in the water-free substance.

ANALYSIS OF ZAMIA INTEGRIFOLIA. ("COONTIE.")

A specimen of the bulbous stem of this plant, from which "Florida arrow-root" is obtained, furnished by Mr. W. H. Gleason and weighing a little less than ¼ pound, was ground up without peeling and gave upon analysis the following results. This stem was picked in April, at which time it is supposed to contain a greater amount of starch than at any other.

An analysis of the corresponding portion of the *Maranta arundinacea*—from which "Bermuda arrow-root" is manufactured—by M. Benzon, is given for comparison.

There still remains to be examined the ether and alcohol extracts for a poisonous body supposed to exist in the plant; also the seeds of the plant for a similar purpose.

Constituents.	*Zamia integrifolia.*	*Maranta arundinacea.*	
		1.	2.
Volatile oil	....	.07	.18
Fixed oil, &c., extracted by ether	1.06	....	....
Substance, not sugar, soluble in alcohol and water; insoluble in ether.	3.67	....	....
Glucose	.21	....	....
Sucrose	.53	....	....
Gummy extract	3.02	.60	1.51
Albumin	....	1.58	3.97
Albuminoids insoluble in alcohol	7.44	....	....
Albuminoids soluble in alcohol	.61	....	....
Starch	64.78	26.00	65.41
Fiber	3.93	6.00	15.10
Calcic chloride	....	.25	.63
Ash	1.67	....	....
Water	13.20	65.50	13.20
	100.12	100.00	100.00

Maranta arundinacea.—Analysis No. 1, is the original by M. Benzon; No. 2 is the same calculated to 13.20 per cent. of water.

ANALYSIS OF SWORD BEAN. (*Canavalia gladiata*, var. *ensiformis.*)

These beans were received from Mr. W. J. Donaldson, Georgetown, S. C., who reports that they grow readily, require only ordinary culture, and yield prolifically, the product from twelve beans in the second crop being sufficient to furnish seed for ten acres. The results of an analysis are appended; the beans seem therefore to be good for food for animals and probably for man.

Constituents.	Air-dry beans.	Dry beans.
Water	10.37	....
Ash	2.68	2.99
Oils	3.12	3.48
Substance resembling cane-sugar	3.50	3.90
Gum	4.69	5.23
Starch, by difference	40.41	45.10
Non-nitrogenous extractive, soluble in alcohol and water	4.50	5.02
Albuminoids, insoluble in water and soluble in 80 per cent. alcohol	1.51	1.68
Albuminoids, soluble in water and alcohol coagulated by acid	.32	.36
Albuminoids not included above	24.77	27.63
Cellulose	4.13	4.61
	100.00	100.00

AN APPARATUS FOR CONTINUOUS PERCOLATION.

The cut (see Plate VI) plainly shows the construction of the very simple and efficient apparatus here used for the extraction of vegetable substances with such volatile solvents as ether, alcohol, naphtha, chloroform, &c.

This apparatus has been described by several German and American chemists, but it has so many advantages over most forms that it is again presented. In any convenient water-tight vessel is a worm of block-tin pipe having an internal diameter of 9^{mm} and a length of about two to two and one-half meters. The lower part of this worm is fitted by an ether-soaked velvet cork to a glass percolator having a diameter of 4^{cm}, a length of 20^{cm} to the constriction and 5^{cm} below.

Within the percolator is a smaller tube, flanged at top and bottom, having a diameter of 2.5 to 2.8^{cm} and a length of 14^{cm}.

As here figured, the keg used for four percolators has a height of 45^{cm} and a diameter at top and bottom of 30^{cm}. It stands on a cylinder of wood which extends above the table 35^{cm}.

A light glass flask, weighing about 30 grams, is fitted by an ether-soaked cork to the percolator. The bottom of the inner tube is covered by filter paper and fine washed linen, tied on by linen thread. Two to five grams of the finely-pulverized drug are introduced and the tube is suspended in the percolator by fine copper or platinum wires, the flask connected below, and the solvent is poured on the drug in the tube.

The whole apparatus is then fitted to the worm by means of the large cork above and heat is applied to the flask by means of water-bath and Bunsen's burner.

The following liquids have been used for extraction and no trouble has been experienced in volatilizing them from the water-bath so completely as to keep the drug under extraction constantly covered with liquid: Ether, absolute and 80 per cent. alcohol, carbon disulphide, chloroform, methylic alcohol, and petroleum ether. Where the liquid volatilizes with difficulty it is well to wrap a paper or towel around the percolator to prevent cooling the vaporized solvent before it reaches the condenser.

It is possible to get closely accordant quantitative results by a judicious selection of solvents.

The size of the percolator may be increased considerably without a corresponding enlargement of the condenser.

This particular form seems originally to have been designed by Tollens, and described by him in 1875 and again in 1878. It has been variously modified by Shulze, 1878; by Johnson, Atwater, and several others. The only changes here made have been in cheapening the apparatus by using ordinary wine kegs for containing the block-tin condensers, and in suspending the inner tube by wires instead of supporting it from below on a wire coil.

As a matter of interest the following references are given to show the large number of forms of extraction apparatus which have been described:

PAYEN.—Anleit. zur Zoo. Chem. anal. (1854), pp. 13, 14, mentioned Zeitsch. f. anal Chem. (1868), vii, p. 68.

DRAGENDORFF.—Schweiz, Zeitsch. f. Pharm vii, p. 160, Zeitsch. für anal. Chem. (1862), i, p. 490.

BIBRA.—Gorup-Besanez, Zoo. Chem. anal. (1871), 3th aufl. s. 11.

O. STORCH.—Zeitsch. f. anal. Chem. ([illegible]), vii, p. [illegible] (illustrated), from "Tidsskrift for Physik ay Chemie" (1867), vi, p. 193.

ZULKOWSKI.—Dingl. polyt. Journal, 203, [illegible]; Zeitsch. f. anal. Chem. (1873) xii, p. 303, a modification of O. Storch's apparatus.

P. WAGNER.—Zeitsch. f. anal. Chem. (1870), ix, p. 354 (illust.).

E. SIMON.—Zeitsch. f. anal. Chem. ([illegible]), [illegible], p. [illegible] (illust.).

SCHLOESING.—Traité d'Analyse des Matières Agricoles ([illegible]), p. [illegible] (illust.).

LUDWIG MEDICUS.—Zeitsch. f. anal. Chem. ([illegible]), [illegible].

B. TOLLENS.—Journ. f. Landw. [illegible], p. [illegible] (1874); Zeitsch. f. anal. Chem. (1875), xiv, p. [illegible] and ([illegible]), xvii, p. 320 (illust.), New Remedies, N. Y. (Nov., 1878), p. 335 (illust.).

E. SCHULZE.—Zeitsch. f. anal. Chem. (1878), p. 175 (illust.). A modification of Tollens's apparatus.

E. DRESCHEL.—Zeitsch. f. anal. Chem. (1877), xvi, 464 (plate).

S. W. JOHNSON.—Amer. Jour. Sci. Arts. xiii, p. 196 (illust.), Amer. Chem. vi, 106. Jahresbericht f. Chemie (1875), p. 1094. Tollens's apparatus.

W. O. ATWATER.—Proc. Amer. Chem. Soc. [2], No. 2, p. 85 (illust.), Tollens's apparatus.

H. B. PARSONS.—New Remedies (Oct., 1879), viii, p. [illegible] (illust.), Amer. Chem. Journ (Feb., 1880), i, p. 378, Tollens' apparatus.

REPORT ON GRASSES AND FORAGE PLANTS.

Since the appearance of the last report fifty-six analyses of forage plants and hays have been made, which, with thirty-four previously published (Report for 1878), form a series of the principal wild grasses of the South and West, some of those well known in the North, and several forage and other plants not hitherto examined.

The following list contains the names and localities of collection of all the specimens analyzed during 1878, 1879, and 1880. Nos. 1 to 33, with 42 and 45, which were analyzed and published last year, are repeated here, with their analyses corrected in a few points for comparison:

GRASS AND FODDER PLANTS ANALYSED DURING 1878, 1879, AND 1880.

WINTER OF 1878-'79.

[From Prof. S. B. Buckley, Austin, Tex.]

No. of anal.
1. *Paspalum læve.* Water-grass.
2. *Andropogon Virginicus.* Broom sedge, sedge-grass.
3. *Panicum Texanum.* Texas millet.
4. *Sorghum nutans.* Wood-grass.
5. *Setaria setosa.* Bristle-grass.
6. *Tricuspis sesleroides.*
7. *Leptochloa mucronata.* Feather-grass.
8. *Panicum obtusum.*
9. *Panicum virgatum.* Fall panic or switch-grass.
10. *Panicum Crusgalli.* Barn-yard grass, cock's foot.
11. *Eleusine Indica.* Yard-grass, crow-foot.
12. *Muhlenbergia diffusa.* Drop-seed grass.

[From Theo. Louis, Louisville, Wis.]

13. *Poa pratensis.* June grass, blue-grass.
14. *Poa serotina.* Fowl meadow-grass.
15. *Agrostis exarata.* Native red-top.

[From D. L. Phares, Woodville, Miss.]

16. *Cynodon dactylon.* Bermuda grass.
17. *Sporobulus Indicus.* Smut-grass.
18. *Tripsacum dactyloides.* Gama-grass.

[From E. Hall, Athens, Ill.]

19. *Hierochloa borealis.* Vanilla-grass.
20. *Bromus carinatus.* California broom-grass.

[From Charles Mohr, Mobile, Ala.]

21. *Lespedeza striata.* Japan clover.
22. *Panicum sanguinale.* Crab-grass.
23. *Panicum jumentorum.*
24. *Panicum virgatum.* Fall panic, switch-grass.
25. *Cynodon dactylon.* Bermuda grass.
29. *Andropogon scoparius.* Broom-grass.
30. *Sorghum halapense.* Johnson grass.
31. *Eleusine Indica.* Yard grass, crow-foot grass.
32. *Panicum filiforme.*

[From Dr. W. A. Carswell, Americus, Ga.]

26. *Eleusine Indica.* Yard grass, crow-foot grass.
27. *Dactyloctænium Ægyptiacum.* Crow-foot grass.
28.

[From Dr. H. W. Ravenel, Charleston, S. C.]

No. of anal.
33. *Desmodium molle.* Beggar lice.

WINTER OF 1879-'80.

[From Charles Mohr, Mobile, Ala.]

34. *Paspalum præcox.*
35. *Panicum anceps.*
36. *Panicum divaricatum.*
37. *Panicum dichotomum.*
38. *Andropogon macrourus.* Broom-grass.
39. *Panicum proliferum.* Large crab-grass.
40. *Panicum Crusgalli.* Barn-yard grass.
41. *Andropogon scoparius* (before bloom).
42. *Uniola latifolia.* Fescue grass.
43. *Panicum gibbum.*
65. *Richardsonia scabra.* Mexican clover.

[From the Department grounds.]

44. *Vichia sativa.* Common vetch.
45. *Bromus unioloides.* Schrader's grass.

[From A. C. Lathrop, Glenwood, Pope County, Minnesota.]

46. *Andropogon furcatus.* Blue-joint grass.
47. *Bouteloua oligostachya.* Gamma grass.
48. *Spartina cynosuroides.* Marsh-grass.
49. *Muhlenbergia glomerata.* Satin grass.

[From James O. Adams, Manchester, N. H.]

50. *Anthoxanthon odoratum.* Vernal grass.
51. *Festuca pratensis.* Field fescue.
52. *Poa compressa.* English blue-grass.
53. *Glyceria nervata.* Fowl meadow-grass.
54. *Festuca ovina.* Sheep fescue.
55. *Bromus secalina.* Common cheat or chess.
56. *Poa pratensis.* Blue-grass.
60. *Muhlenbergia* sp. ? Knot-grass.
61. *Plantago lanceolata.* Ribwort plantain.
62. *Dactylis glomerata.* Orchard-grass.
63. *Triticum repens.* Quick-grass.
64. *Danthonia spicata.* Wild-oat grass.

[From J. D. Waldo, Quincy, Ill.]

58. *Spartina cynosuroides.* Marsh or whip grass.

[From J. E. Snodgrass, North Mountain, W. Va.]

No. of Anal.
57. *Echium vulgare.* Blue weed, blue thistle.

[From D. H. Wheeler, Nebraska.]

No. of anal.

59. *Andropogon furcatus.* Blue-joint.

[From W. S. Robertson, Muscogee, Ind. T.]

66. *Aristida purpurens.* Purple beard-grass.
67. *Andropogon argenteus.* Silver beard-grass.
68. *Scirpus eriophorum.* Woolly sedge-grass.
69. *Uniola latifolia.* Fescue grass.
70. *Panicum agrostoides.* Marsh panic.
71. *Sorghum nutans.*
72. *Tricuspis purpurea.* Purple tricuspis.
73. *Elymus Canadensis.* Wild rye-grass.
74. *Spartina cynosuroides.* Whip-grass.
75. *Andropogon scoparius.*
76. *Panicum capillare.* Witch-grass.
77. *Andropogon furcatus.*
78. *Cinna arundinacea.* Reed-grass.

No. of anal.

79. *Panicum virgatum* (tall). Panic-grass.
80. *Panicum virgatum* (short). Panic-grass.

[From Cyrus G. Pringle, Charlotte, Vt.]

81. *Danthonia compressa.* Wild-oat grass.
82. *Glyceria aquatica.* Reed meadow-grass.
83. *Glyceria nervata.*
84. *Avena striata.* Mountain oat-grass.

[From J. W. Sanborn, Hanover, N. H.]

85. Hay, chiefly timothy, cut ten days before bloom.
86. The same, cut while in bloom.
87. The same, cut after bloom.
90. The same, cut while in bloom.
91. The same, cut after bloom.

[From ——— ———, S. C.]

88. *Phalaris intermedia var angusta.* American canary-grass.

DESCRIPTION OF TABLE I.

In Table I the proximate analyses of the grasses examined during the past year are given in detail, in a similar manner to those published in the report for 1878, but modified in a few particulars.

The figures for *ash* were obtained by burning the plant and weighing the crude ash, instead of determining it pure and sand free, as was done last year. The complete analysis of the ash has been given up as not repaying the labor involved.

The *ether extract, or fat,* has not been separated into wax, fat, and chlorophyl, but is given as a whole.

The 80 *per cent. alcohol extract* has been made more complete by the use of the apparatus figured and described in this report. The action of the alcohol was continued fourteen hours, and, after weighing the extractive matter, dried at 100° C., a separation of the resinous matter from those constituents soluble in water has been attempted. The resins are probably of small nutritive value, while the portion of the extract soluble in water, consisting chiefly of sugar with the soluble nitrogenous matter, is one of the most important parts of the plant.

The *gum* has been extracted as usual by percolation with hot water.

The treatment of the grass with 2 per cent. soda solution before that with acid, which was tried in a few grasses—Nos. 34–42—has given way to the more universally applicable method of boiling first with 2 per cent. acid.

Instead of making a direct estimation of the *acid extract* by neutralization and evaporation, an aliquot portion has been titrated with Fehling's solution and the cuprous oxide obtained calculated to starch and stated as starch isomers. That the grasses contain only minute quantities of actual starch is well known. They contain, however, substances which are convertible by acid into products which reduce Fehling's solution, and at the same time others, probably allied to the pectous substances, which, although extracted by acids, have no effect on Fehling's solution.

In the statement of the analyses, the separation of the two classes seems to be desirable, the latter being included with the alkali extract or undetermined portion of the grass and being of small nutritive value.

The *crude fiber* given in the table was estimated in a different manner from the cellulose of last year. It consists of the ash-free residue of

the grass after extraction with ether, alcohol, water, acid, and alkali, and may be somewhat larger than the amount of cellulose obtained by the more severe treatment with hypochlorite solution. As most determinations of fiber are now made in this manner in fodder analysis, it seemed desirable to conform to common usage in this respect, especially as the German hay analyses show a much higher percentage of fiber than ours, which might have been owing to severer treatment in our methods of working.

As has been the custom the *nitrogen* obtained by combustion with soda lime has been multiplied by the factor 6.25 and the product stated as albumen.

The error of this method of procedure is universally acknowledged, it being well known that this factor does not represent the per cent. of nitrogen present in the nitrogenous constituents of plants, but only that of pure albumen.

Experiments during the past few years have shown that this is not only the case, but that in addition there are present in most plants, bodies containing nitrogen in a smaller proportion than the albuminoids and possessing a greater solubility, which are called amides and amido acids. What their value is as nutrients is not known for lack of experimental evidence. By some they are regarded as of equal value with the albuminoids, by others as of little use. An investigation is at present going forward with a view to the separation and examination of this soluable nitrogenous compound, the results of which must be reserved for a subsequent report.

Whatever the truth may be, it is evident that their presence is of importance in one way or another to the analyst and the farmer, and that some determination of their amount must be attempted in order not to include all the nitrogen found in a plant under the head "albuminoids," where it does not rightly belong.

EXPLANATION OF TABLE II.

As it was found that the 80 per cent. alcohol extract contained large amounts of nitrogen, which, if neglected, would cause the same substance to enter twice into the analysis, once as albuminoids and again in the sugar extract, making both of these divisions larger than they naturally would be, the amount of nitrogen remaining in the residue after extraction with alcohol was determined in all the plants under examination. The difference between this figure and that found for total nitrogen in the original plant of course represents the amount soluble in alcohol. That no further amount of nitrogen was extracted by water was proved by the following experiments:

Number.		Nitrogen contained after extraction with—					
		Nothing.		Average.	Ether.	Alcohol, 80 per cent.	Water.
85	Hay	1.86	1.82	1.84		1.46	1.43
86	...do	1.38	1.40	1.39		1.25	1.20
87	...do	1.57	1.48	1.49	1.51	1.23	1,20

The nitrogen extracted by 80 per cent. alcohol, after 14 hours' treatment, has been stated as soluble nitrogen, and consists probably of amides and amido acids to a large extent. At least albuminoid reagents produced only slight precipitates, except in one or two of the cases where the soluble rose to 60 per cent. of the total nitrogen.

As has been said in Table 1, the nitrogen has been all stated as albuminoid. This has been done merely to carry out the comparison between these analyses and others made previously.

A more correct way to state them, and one which every one can apply for himself, is to deduct from the albuminoids an amount corresponding to the nitrogen soluble, to deduct from the sugar extract a like amount and insert the same in the analysis as soluble nitrogen multiplied by some suitable factor.

As an example, the analysis of Vicia sativa will serve:

Moisture	11.12
Ash	8.00
Ether extract	4.70
Resin	1.99
Sugars	11.79
Soluble N. × 6.25	8.57
Gum	5.96
Starch isomers	14.20
Undetermined	2.63
Crude fiber	13.54
Insoluble N. × 6.25	17.50
	100.00

With the aid of Table II this method of statement can be easily applied to any of the plants analyzed.

Oscar Kellner* has lately published some results of the determinations of the amide nitrogen at various stages of the growth of grasses, which are given in the following table:

Kellner's analyses.

Number.	Names of grasses, &c.	Per cent. of total nitrogen.	Per cent. of non-albuminous nitrogen.	Non-albuminous nitrogen in per cent. of total nitrogen.	Nitrogen as amides compound.
	Red clover, second year's growth.				
1	Cut on March 27; 4 inches high, 3 leaves	5.200	1.958	37.7	....
2	Cut on April 27; 7 inches high, 6 leaves	3.974	0.975	24.5	....
3	In full bloom, 35 inches high	2.244	....	16.5	.370
	Rye.				
1	Cut March 28; 8 inches high	4.433	1.701	38.5	1.245
2	Cut April 30; 35 inches high	3.574	0.901	25.2	0.758
	Italian rye-grass, second year.				
1	Cut April 1	3.921	1.140	29.1	....
2	Cut May 15	1.864	.320	16.1	0.304
	Arena elatior, second year.				
1	Cut April 4; 17 inches high	4.664	1.460	31.3	....
2	Cut May 23; 55 inches high	2.420	.637	26.3	....
	Dactylis glamerata.				
1	Cut April 4; 15 inches high	5.091	1.306	25.8	....
2	Cut May 23; 45 inches high	2.533	0.4502	17.8	....
	Meadow hay.				
1	Cut May 4	2.824	.983	34.8	.892
2	Cut June 9	1.787	.285	16.0	.239
3	Cut June 29	1.354	.102	7.5	.033

* Chem. Central Blatt. X, p. 744.

He shows that the amount varies, decreasing from the early stages of growth to maturity, and in this connection it is of interest to discover whether a young hay containing a large amount of amides possesses the nutritive value of one cut later. The only experiments in this country are those lately carried out by Mr. J. W. Sanborn, of New Hampshire, from which he concludes that, weight for weight, his cattle do better on the older or later cut hay, while they will eat more of the early cut. This single experiment of course needs confirmation, and it is in this direction that the farmer should work to aid the chemist to a practical application of the results of his laboratory work.

It is to be regretted that more accurate data are not at hand as to the development of the grasses analyzed by us. At present, however, series of the most important grasses are being collected, which will be analyzed to show the effect of development on their nitrogen content and condition.

EXPLANATION OF TABLE III.

Table III contains all the analyses of fodder plants made during the past two years stated according to the Weende method, which is employed generally in Europe and by many analysts in this country. It possesses the advantage of simplicity, and, as far as judging of fodder values is concerned, furnishes us with all the data which we are able to interpret with our present knoweldge of the digestibility of the various constituents of grasses, &c. By means of this table we are able to compare the American grasses with those examined in Germany; to apply as far as is suitable the conclusions drawn from long years of work in that country to the results which we have obtained.

Under this arrangement everything not ash, fat, crude fiber, nitrogenous substance, and moisture is included under the designation "nitrogen free substance."

In the analyses from 1 to 33, the ash differs from that given last year by including the sand. One or two corrections have also been made in the amount of albumen. In the latter columns of the table the quality of the grass and the ratio of the nutritive ingredients are given.

The former is a mere arbitrary designation, based upon the average composition of American grasses.

The latter is the ratio between the fats and carbohydrates and the albuminoids, and is commonly known as the nutritive ratio. It shows whether the fodder is complete in itself, or whether, in order to obtain its full value, it must be combined with some other having an excess of that constituent wanting in the fodder in question. It has been found that the animal requires the ratio of carbohydrates and fats to albuminoids to be in the proportion of about five to one in order to live with the greatest advantage and most economically, since this proportion represents the ordinary demands of the animal economy.

To more fully understand this matter, it is necessary to consider the different functions of food in the animal. These functions are mainly these:

1st. The supplying of material necessary to the development of the growing animal.

2d. To provide for waste of tissue constantly going on.

3d. To furnish muscular force.

4th. To furnish animal heat.

The above represents what may be regarded as the normal wants of the animal; but in the case of cows giving milk, for example, there is

another demand to be met by the food supply, and a proper regard to the food necessary to supply this demand is of the greatest practical importance to the farmer.

Since the tissues of the body are mainly composed of nitrogenous and phosphatic material, it is obvious that for the production of such tissues in the young animal, and for the repair of their waste in the adult, only food which is made up of such nitrogenous or phosphatic material will suffice for such purpose; but for the other functions of food, viz., the supply of animal heat and muscular force, other kinds of food, those rich in carbohydrates, will suffice, since it appears to be conclusively established by experiment, the results of which are universally accepted, that animal heat and muscular force proceed from the combustion or oxidation of food constituents in the blood.

But these latter functions of food may be performed by the oxidation of nitrogenous or phosphatic foods as well as by that of the carbohydrates, and such is found to be the case when through lack of sufficient food, either partial or complete starvation, it is found that the animal becomes emaciated, and, in fact, the functions of life are being performed at the expense of the muscular tissues, after the reserve supplies of fat in the body have become exhausted.

True economy in feeding, therefore, demands that the proper proportion of these three kinds of food be provided; and since the carbohydrates are much cheaper than the other kinds, it is advisable that only sufficient quantity of the other kinds be furnished for the full performance of those functions of which these only are capable, namely the supply of the tissues, since any other procedure would be extravagant and wasteful.

A judicious combination of fodders so as to produce this result, and a utilization of the fodders in his possession by mixture with others which he may buy, so as to economize all the nutrients, is the problem which should occupy the farmer to-day.

It is in this direction that the chemist is able to furnish great assistance to the stock-raiser, by analyses of fodder stuffs which shall show him how to feed them economically, by calculating suitable rations of various substances, by finding values to apply to the digestible portions of fodders in order to calculate their cost in the market, and by practical feeding experiments to show how we may interpret the results obtained in the laboratory.

THE CALCULATION OF FODDER VALUES.

In the description of the analyses of grains, p. —, mention has been made of the figures assigned by Wolf and Koenig to the nutritive constituents of the cereals for determining their values; and the manner of deducing others, suitable to the American market, from the average value of crops for the last ten years' has been explained.

In the case of hay, the average value since 1870 has been $12.86 per ton; and this, taken in conjunction with the average composition of American grasses analyzed by us, gives the following:

Values of the available nutrients of American hay.

Albuminoids	3.16 cents per pound.
Fats	2.93 cents per pound.
Nitrogen, free extract	.72 cent per pound.

These figures have been used in the calculation of the relative fodder values given in one of the last columns of the table. It will be seen

that they are very much lower than those for the grains, which is of course to be expected. There are several points about these money values which should be explained to show their use.

Two or more grasses varying in composition may have the same values. This means that all are worth the same as fodder if used so as to economize all the nutrients.

A clover hay whose composition might be—

Moisture	16.7
Fat	3.2
Nitrogen, free extract	32.9
Crude fiber	29.9
Albuminoids	11.0
Ash	6.3

is worth, according to the values given above, $14.10 per ton; that is to say, it contains nutritive ingredients of that value. If used in combination with other fodder poor in nitrogen but rich in carbohydrates, the nutritive ratio will be made normal and the full value of the clover would be realized; but if it were fed alone, the excess of nitrogen contained in the clover beyond that which was necessary to the right proportion to the carbohydrates present, would, as we have seen, be fed wastefully, since it would be supplying the place of other and cheaper food.

The ratio of fats and carbohydrates to the albuminoids being 1 to 3.28, about 35 per cent. of the nitrogen would thus be fed at a waste by feeding the hay alone, and, therefore, while this hay, properly fed, would have a nutritive value of $14.10, only $11.50 worth would be economically fed, while the remaining $2.60 worth of nutritive material would simply serve the purpose of an equivalent amount of carbonaceous food of a much less market value.

Many considerations of course affect these methods of rational feeding, and persons interested can do no better than read some of the admirable German works on the subject, which, although perhaps not strictly applicable to our climate and stock, will point out to the farmer the direction in which investigations on this subject must be pushed. But few experiments have been made in the United States, and when we consider what an immense amount of time and experience has been devoted to this subject on the Continent, it is impossible not to see the extent of the work which is before us to put the farmer on as sound a basis in this country.

COMPARISON OF AMERICAN AND GERMAN GRASSES.

Wolff and Kühn give the following tables of the average composition of German grasses, which are of interest to compare with our own given afterwards:

Wolff's tables of the composition of hay from German grasses.

Conditions.	Water.	Ash.	Total N. × 6.25.	Fiber.	N. free extract.	Fat.
Poor	14.30	5.00	7.50	33.50	38.20	1.50
Fair	14.30	5.40	9.20	29.20	39.70	2.00
Good (average)	14.30	6.20	9.70	26.30	41.00	2.50
Very good	15.00	7.00	11.70	21.90	41.60	2.80
Extra	16.60	7.70	13.50	19.30	40.40	3.00
Average good, dry	....	7.23	11.32	30.69	47.84	2.92

Kühn's average composition of German hay.

Varieties.	Water.	Ash.	Fat.	N. free extract.	Crude fiber.	Albuminoids.	Nutrit. ratio.
Meadow hay	14.3	6.5	2.3	40.3	27.1	9.5	1:4.5
Hay from sweet grasses	14.3	5.8	2.6	39.1	28.7	9.5	1:4.5

Average of American wild grasses.

Varieties.	Water.	Ash.	Fat.	N. free extract.	Crude fiber.	Albuminoids.	Nutrit. ratio.
Dry grass	....	7.9	2.9	53.9	27.1	8.2	1:6.9
Grass cured as hay	14.3	6.8	2.5	46.2	23.2	7.0	1:6.9

If we regard these averages as representing German and American hays it will be seen how much poorer the latter are in nitrogen than the former, the poorest German hay having more than the average American. But in regard to carbohydrates and fiber our hays are the best, fiber being much lower and carbohydrates much higher, so there is no good reason for calling our hays all poor, especially as the nutritive ratio is more nearly normal. A different classification is all that is necessary.

It will be noticed that the average water content of German hay is given as 14.3 per cent. This has been accepted in this country and applied in the table to all the grasses for the sake of comparison. There is in all our determinations of moisture none so high as this, the average of the grasses being 7.86 per cent., but they had hung in a warm place for some time before analysis. Experiments to be made next year on this point will be decisive.

DIGESTIBILITY OF THE CONSTITUENTS OF GRASSES.

It must be remembered that in the analyses the total amount of the nutrients present in the grasses is given, but that under the most favorable conditions all of this cannot be digested by the animal. How much can be assimilated is to be found only by practical experiment. This has been done in Germany with many fodders, and the results of some of the most important, as given by Kühn, are here tabulated.

Digestibility of the constituents of various fodders.

JULIUS KÜHN.

Varieties.	Protein substance.			Fat.			N. free substance.			Crude fiber.		
	Maximum.	Minimum.	Probable mean.	Maximum.	Minimum.	Probable mean.	Maximum.	Minimum.	Probable mean.	Maximum.	Minimum.	Probable mean.
Pasture grass	70.6	79.3	75	63.4	68.1	66	74.5	84.4	79	70.3	75.2	73
Mowing grass	69.0	71.7	70	60.4	68.1	65	74.7	84.4	79	65.4	72.8	69
Red clover:												
Shortly before bloom	70.5	74.3	73	57.0	65.2	62	69.6	83.2	76	50.1	60.4	55
Beginning to bloom	71.7	76.3	74	66.1	75.3	71	73.0	80.1	77	52.2	59.2	56
Full bloom	64.7	70.2	67	58.6	65.4	63	68.3	72.6	70	46.4	50.1	48
Towards end of bloom	56.4	60.8	59	42.2	46.7	45	70.3	71.0	71	38.3	39.3	39
Corn-fodder	......	......	73	......	......	75	......	......	67	......	......	72
Hay	38.9	71.0	57	8.5	69.7	46	48.0	78.8	63	44.6	72.4	58
Aftermath	53.0	68.0	61	27.0	57.4	46	56.7	75.0	66	54.3	74.9	63

Digestibility of the constituents of various fodders—Continued.

Varieties.	Protein substance.			Fat.			N. free substance.			Crude fiber.		
	Maximum.	Minimum.	Probable mean.	Maximum.	Minimum.	Probable mean.	Maximum.	Minimum.	Probable mean.	Maximum.	Minimum.	Probable mean.
Clover hay	43.0	73.3	60	33.0	75.3	59	62.5	80.1	69	38.0	59.2	47
Wheat straw	......	......	26	......	......	27	......	......	40	......	......	52
Rye straw	2.6	82.6	25	21.2	40.9	32	28.5	51.8	36	46.8	72.9	56
Oat straw	14.4	50.0	38	14.0	51.0	30	33.2	47.0	42	53.0	67.0	61
Oats	58.0	81.3	74	68.4	99.0	82	65.0	79.7	73	5.5	32.1	21
Corn	83.9	88.1	85	74.4	78.5	76	92.5	93.3	94	17.0	57.4	34
Beans	80.6	100	90	86.9	100	97	90.7	98.7	94	25.1	100	63
Pease	84.4	91.5	88	45.0	69.0	58	94.7	98.6	97	55.1	86.5	74
Linseed cake, with oxen	80.2	89.9	87	86.7	93.9	91	85.0	96.3	91	......	54.5	54
Wheat bran, dry	82.9	93.5	88	77.6	81.6	80	77.7	81.2	80	16.9	32.2	20
Wheat bran, cooked	61.6	81.0	70	68.8	89.9	81	69.7	82.4	75	3.5	21.5	13

In this table the maximum and minimum amount digested of each constituent in various experiments are given, together with the probable mean. How much we may depend on these determinations for our American fodders is doubtful. They serve, however, to show in what direction we must work, and what assistance chemistry can render the farmer.

To show how these tables are used in connection with fodder analyses an example may serve. A farmer has a milch cow which he wishes to feed in the most economical manner on the fodder at his disposal, combined with other food purchased, and with a view of obtaining the best return in milk. It has been found that a milch cow requires, as a daily ration, for every 1,000 pounds live weight, according to Kühn—

	Pounds.
Dry organic substance	20.0 to 30.0
Digestible albuminoids	2.0 to 2.7
Digestible fats	0.4 to 0.7
Digestible nitrogen, free extract	12.5 to 15.0
Digestible substance	15. to 17.0
Nutritive ratio, about	1 to 6

The farmer has an average (German) hay and mangolds, which, if fed together, would make a ration too rich in carbohydrates. Taking into consideration his ability to purchase, he finds from the analyses, digestibility and fodder value, that he can make this up in the best way by buying cotton-seed meal and constituting the ration as follows:

Quantities.	Dry organic matter.	Digestible albuminoids.	Digestible carbohydrates.	Digestible fats.
24 pounds average hay	19.0	1.20	9.84	0.24
40 pounds mangolds	4.4	.44	4.00	0.06
2 pounds cotton-seed meal	1.6	.62	.36	0.24
	25.0	2.26	14.20	0.54

Of course, it is necessary that a farmer's judgment should be used in the matter as well as the mere data given in the tables. The ration must be palatable to the animal and in proper form.

Wolff's tables of the composition, digestibility, and value of feeding stuffs, and his table of feeding standards, are copied here from the admirable report of the Connecticut Agricultural Experiment Station. They are not so good as those given by Kühn in *Mentzel und Von Lengerke's Landwirthschaftliches Kalender für* 1880, but are more concise. It must always be remembered that these figures are derived from German experiments, and will probably be modified in the future for this country.

Feeding standards.

[Per day and per 1,000 pounds live weight.]

Age and condition.	Average live weight, per head.	Total organic substance.	Nutritive (digestible) substances. Albuminoids.	Carbohydrates.	Fat.	Total nutritive substance.	Nutritive ratio.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
1. Oxen at rest in a stall	....	17.5	0.7	8.0	0.15	8.85	1 : 12
2. Wool sheep, coarser breeds	....	20.0	1.2	10.3	0.20	11.70	1 : 9.
Wool sheep, finer breeds	....	22.5	1.5	11.4	0.25	13.15	1 : 8.
3. Oxen moderately worked	....	24.0	1.6	11.3	0.30	13.20	1 : 7.5
Oxen heavily worked	....	26.0	2.4	13.2	0.50	16.10	1 : 6.
4. Horses moderately worked	....	22.5	1.8	11.2	0.60	13.60	1 : 7.
Horses heavily worked	....	25.5	2.8	13.4	0.80	17.00	1 : 5.5
5. Milk cows	....	24.0	2.5	12.5	0.40	15.40	1 : 5.4
6. Fattening oxen, first period	....	27.0	2.5	15.0	0.50	18.00	1 : 6.5
Fattening oxen, second period	....	26.0	3.0	14.8	0.70	18.50	1 : 5.5
Fattening oxen, third period	....	25.0	2.7	14.8	0.60	18.10	1 : 6.0
7. Fattening sheep, first period	....	26.0	3.0	15.2	0.50	18.70	1 : 5.5
Fattening sheep, second period	....	25.0	3.5	14.4	0.60	18.50	1 : 4.5
8. Fattening swine, first period	....	36.0	5.0	27.2		32.50	1 : 5.5
Fattening swine, second period	....	31.0	4.0	24.0		28.00	1 : 6.0
Fastening swine, third period	....	23.5	2.7	17.5		20.20	1 : 6.5
9. Growing cattle—							
Age in months: 2 to 3	150	22.0	4.0	13.8	2.0	19.8	1 : 4.7
3 to 6	300	23.4	3.2	13.5	1.0	17.7	1 : 5.0
6 to 12	500	24.0	2.5	13.5	0.6	16.6	1 : 6.0
12 to 18	700	24.0	2.0	13.0	0.4	15.4	1 : 7.0
18 to 24	850	24.0	1.6	12.0	0.3	13.9	1 : 8.0
10. Growing sheep—							
Age in months: 5 to 6	56	28.0	3.2	15.6	0.8	19.6	1 : 5.5
6 to 8	67	25.0	2.7	13.3	0.6	16.6	1 : 5.5
8 to 11	75	23.0	2.1	11.4	0.5	14.0	1 : 6.0
11 to 15	82	22.5	1.7	10.9	0.4	13.0	1 : 7.0
15 to 20	85	22.0	1.4	10.4	0.3	12.1	1 : 8.0
11. Growing fat pigs—							
Age in months: 2 to 3	50	42.0	7.5	30.0		37.5	1 : 4.0
3 to 5	100	34.0	5.0	25.0		30.0	1 : 5.0
5 to 6	125	31.5	4.3	23.7		28.0	1 : 5.5
6 to 8	170	27.0	3.4	20.4		23.8	1 : 6.0
8 to 12	250	21.0	2.5	16.2		18.7	1 : 6.5
Growing cattle—							
Age in months: 2 to 3	150	3.3	0.6	2.1	0.30	3.00	1 : 4.7
3 to 6	300	7.0	1.0	4.1	0.30	5.40	1 : 5.0
6 to 12	500	12.0	1.3	6.8	0.30	8.40	1 : 6.0
12 to 18	700	16.8	1.4	9.1	0.28	10.78	1 : 7.0
18 to 24	850	20.4	1.4	10.3	0.26	11.96	1 : 8.0
Growing sheep—							
Age in months: 5 to 6	56	1.6	0.18	0.87	0.045	1.095	1 : 5.5
6 to 8	67	1.7	0.17	0.85	0.040	1.060	1 : 5.5
8 to 11	75	1.7	0.16	0.85	0.037	1.047	1 : 6.0
11 to 15	82	1.8	0.14	0.89	0.032	1.062	1 : 7.0
15 to 20	85	1.9	0.12	0.88	0.025	1.047	1 : 8.0
Growing fat swine—							
Age in months: 2 to 3	50	2.1	0.38	1.50		1.88	1 : 4.0
3 to 5	100	3.4	0.50	2.50		3.00	1 : 5.0
5 to 6	125	3.9	0.54	2.96		3.50	1 : 5.5
6 to 8	170	4.6	0.58	3.47		4.05	1 : 6.0
8 to 12	250	5.2	0.62	4.05		4.67	1 : 6.5

Average composition, digestibility, and money value of feeding stuffs, as given by Dr. Wolff for Germany for 1879, *except those in italics.*

Varieties.	Water.	Ash.	Nitrogenous matters, albuminoid and amides.	Fiber.	Nitrogen-free extract.	Fat.	Digestible nutrients.			Nutritive ratio.*	Value.	
							Albuminoides.	Carbhydrates, including fiber.	Fat.		Dollars per 100 pounds.	Comparison with meadow hay=1.
Meadow hay, poor	14.3	5.0	7.5	33.5	38.2	1.5	3.4	34.9	0.5	10.6	0.48	0.74
Meadow hay, fair	14.3	5.4	9.2	29.2	39.7	2.0	4.6	36.4	0.6	8.3	0.55	0.86
Meadow hay, average	14.3	6.2	9.7	26.3	41.4	2.5	5.4	41.0	1.0	8.0	0.64	1.00
Meadow hay, very good	15.0	7.0	11.7	21.9	41.6	2.8	7.4	41.7	1.3	6.1	0.74	1.17
Meadow hay, extra	16.0	7.7	13.5	19.3	40.4	3.0	9.2	42.8	1.5	5.1	0.84	1.32
Clover hay, average	16.0	5.3	12.3	26.0	38.2	2.2	7.0	38.1	1.2	5.9	0.69	1.08
Clover hay, best	16.5	7.0	15.3	22.2	35.8	3.2	10.7	37.6	2.1	4.0	0.88	1.39
Timothy hay	14.3	4.5	9.7	22.7	45.8	3.0	5.8	43.4	1.4	8.1	0.69	1.09
Hungarian hay	13.4	5.7	10.8	29.4	38.5	2.2	6.1	41.0	0.9	7.1	0.66	1.04
Rye straw	14.3	4.1	3.0	44.0	33.3	1.3	0.8	36.5	0.4	46.9	0.35	0.55
Oat straw	14.3	4.0	4.0	39.5	36.2	2.0	1.4	40.1	0.7	29.9	0.44	0.69
Rich pasture grass	78.5	2.2	4.5	4.0	10.1	1.0	3.4	10.9	0.6	3.6	0.27	0.42
Average meadow grass, fresh	70.0	2.1	3.4	10.1	13.4	1.0	1.9	14.2	0.5	8.1	0.22	.36
Green maize, German	85.0	1.0	1.2	4.7	7.6	0.5	0.7	7.4	0.2	11.3	.10	.16
Green maize, Mr. Webb, 1874†	86.0	0.8	0.8	4.8	7.3	0.3	0.6	8.3	0.2	14.4	.11	.17
Cured maize fodder, Mr. Webb, of Connecticut†	27.3	4.2	4.4	25.0	37.9	1.3	3.2	43.4	1.0	14.4	.57	.91
Potatoes	75.0	0.9	2.1	1.1	20.7	0.2	2.1	21.8	0.2	10.6	.29	.46
Carrots	85.0	0.9	1.4	1.7	10.8	0.2	1.4	12.5	0.2	9.3	.18	.28
Mangolds	88.0	0.8	1.1	0.9	9.1	0.1	1.1	10.0	0.1	9.3	.14	.22
Rutabagas	87.0	1.0	1.3	1.1	9.5	0.1	1.3	10.6	0.1	8.3	.15	.24
Turnips	92.0	0.7	1.1	0.8	5.3	0.1	1.1	6.1	0.1	5.8	.11	.16
Sugar beets	81.5	0.7	1.0	1.3	15.4	0.1	1.0	16.7	0.1	17.0	.19	.30
Maize, German	14.4	1.5	10.0	5.5	62.1	6.5	8.4	60.6	4.8	8.6	1.10	1.73
Maize, American†	14.4	1.5	10.7	2.0	66.5	4.9	9.0	63.3	3.7	8.0	1.12	1.75
Oats	14.3	2.7	12.0	9.3	55.7	6.0	9.0	43.3	4.7	6.1	.97	1.53
Rye	14.3	1.8	11.0	3.5	67.4	2.0	9.9	65.4	1.6	7.0	1.09	1.68
Barley	14.3	2.2	10.0	7.1	63.9	2.5	8.0	58.9	1.7	7.9	0.95	1.47
Pease	14.3	2.4	22.4	6.4	52.5	2.0	20.2	54.4	1.7	2.9	1.44	2.25
Field beans	14.5	3.1	25.5	9.4	45.9	1.6	23.0	50.2	1.4	2.3	1.51	2.36
Squashes	89.1	1.0	0.6	2.7	6.5	0.1	0.4	7.1	0.1	18.4	.08	.13
Malt sprouts	10.1	7.2	24.3	14.3	42.1	2.1	19.4	45.0	1.7	2.5	1.31	2.06
Wheat bran, coarse	12.9	6.6	15.0	10.1	52.2	3.2	12.6	42.6	2.6	3.9	1.04	1.63
Wheat bran, fine	13.1	5.4	14.0	8.7	55.0	3.8	11.8	44.3	3.0	4.4	1.03	1.62
Middlings	11.5	3.0	13.9	4.8	63.5	3.3	10.8	54.0	2.9	5.7	1.07	1.68
Rye bran	12.5	5.2	14.5	5.7	56.6	4.5	12.2	46.2	3.6	4.5	1.10	1.72
Palm-nut cake	10.5	4.2	16.9	17.4	41.0	10.0	16.1	55.4	9.5	4.9	1.61	2.51
Cotton seed cake, decorticated	11.2	7.6	38.8	9.2	19.5	13.7	31.0	18.3	12.3	1.6	2.05	3.22
Scrap, by Goodale's process†	11.5	......	64.0	......	......	4.6	57.6	......	4.1	0.2	2.67	4.17
Fish-scrap, dry ground†	11.7	......	51.5	......	......	8.1	46.4	......	6.2	0.3	2.28	3.56
Dried blood	12.0	4.1	80.8	......	2.6	0.5	54.1	2.6	0.5	......	2.39	3.76
Whey	92.6	0.7	1.0	......	5.1	0.6	1.0	5.1	0.6	6.6	.11	.18
Milk	87.5	0.7	3.2	......	5.0	3.6	3.2	5.0	3.6	4.4	.34	.53

*Nutritive ratios are read, 1: 10.6, 1: 8.3, &c.
†Connecticut Agricultural Experimental Station, 1879, p. 75.

TABLE I.—*Proximate analysis in detail*

Number.	Varieties.	Locality.	Water.	Ash.	Wax fat.	Sugar and soluble nitrogen.	Resins and color.
	LEGUMINOSÆ.						
44	*Vicia sativa.* Common vetch	Grounds	11.12	8.00	4.70	21.34	1.99
	MISCELLANEOUS PLANTS.						
57	*Echium vulgare.* Blue weed, blue thistle	W. Va	7.92	6.25	2.47	4.70	.17
61	*Plantago lanceolata.* Ribwort plantain	N. H	7.85	6.90	4.11	12.70	3.11
65	*Richardsonia scabra.* Mexican clover	Ala	6.34	7.82	2.89	5.84	3.81
	GRAMINEÆ.						
49	*Muhlenbergia glomerata.* Satin grass	Minn	6.10	14.10	5.42	7.34	2.34
60	*sp?* Knot grass	N. H	8.56	5.80	3.41	12.90	1.53
88	*Phalaris intermedia.* American canary grass	S. C	......	......	......	......	......
45	*Bromus unioloides.* Schrader's grass	Grounds	12.63	8.51	3.12	7.40	1.57
55	*secalina.* Common cheat or chess	N. H	9.22	6.46	3.70	9.49	1.77
43	*Panicum gibbum*		9.95	7.68	3.75	12.10	1.62
39	*proliferum.* Large crab grass	Ala	11.83	9.85	2.65	9.60	4.50
36	*divaricatum*	..do	10.02	12.86	2.27	2.75	3.20
40	*Crusgalli.* Barn-yard grass	..do	8.08	6.42	1.98	8.77	1.82
76	*capillare.* Witch grass	Ind. T	4.78	5.32	3.70	11.30	.75
37	*dichotomum*	Ala	8.41	9.28	3.25	2.47	3.55
70	*agrostoides.* Marsh panic	Ind. T	4.87	6.36	5.41	5.58	1.87
35	*anceps*	Ala	11.57	8.00	1.62	3.67	1.48
80	*virgatum* (short). Panic grass		6.15	5.15	3.12	11.05	2.35
79	*virgatum* (tall). Panic grass		5.90	4.30	2.80	9.65	3.57
63	*Triticum repens.* Quick grass	N. H	7.00	8.67	3.27	9.76	3.47
42	*Uniola latifolia.* Fescue grass	Ala	10.16	13.15	2.80	5.87	......
69	*latifolia.* Fescue grass	Ind. T	5.46	9.85	2.35	5.60	2.01
51	*Festuca pratensis.* Field fescue	N. H	7.97	8.40	3.02	9.08	1.60
54	*ovina.* Sheep fescue	..do	8.82	4.59	3.88	9.43	4.88
48	*Spartina cynosuroides.* Marsh grass	Minn	5.38	6.83	3.24	7.92	3.23
58	*cynosuroides.* Marsh or whip grass	Ill	5.40	6.20	2.80	11.62	3.99
74	*cynosuroides.* Whip grass	Ind. T	6.80	4.85	3.17	9.34	2.33
83	*Glyceria nervata*	Vt	7.05	5.75	2.97	9.35	2.44
82	*agualica.* Reed meadow grass	..do	5.50	6.90	2.07	4.95	......
53	*nervata.* Fowl meadow grass	N. H	7.36	6.30	2.70	10.30	2.91
84	*Avena striata.* Mountain oat grass	Vt	4.25	4.75	3.83	8.60	2.00
47	*Boutelloua oligostachya.* Gamma grass	Minn	8.15	7.17	2.87	4.96	2.55
50	*Anthoxanthon odoratum.* Vernal grass		8.08	7.75	3.13	7.92	1.74
62	*Dactylis glomerata.* Orchard grass	N. H	6.28	7.91	3.27	9.16	4.98
46	*Andropogan furcatus.* Blue joint grass	Minn	8.70	4.65	2.76	9.40	3.18
59	*furcatus.* Blue joint	Nebr	7.95	7.24	1.93	3.69	1.23
77	*furcatus*	Ind. T	6.88	3.80	2.97	8.86	2.64
41	*scoparius.* Before bloom	Ala	9.62	6.43	1.67	4.27	2.18
75	*scoparius*	Ind. T	7.00	4.15	2.97	7.70	.57
38	*macrourus.* Broom grass	Ala	9.02	3.40	2.31	4.22	4.19
67	*argenteus.* Silver beard grass		6.27	3.40	2.87	3.74	3.07
72	*Tricuspis purpurea.* Purple tricuspis	Ind. T	4.35	4.94	3.55	7.26	1.67
81	*Danthonia compressa.* Wild oat grass	Vt	7.55	3.30	3.25	7.55	......
64	*spicata.* Wild oat grass	N. H	3.29	4.24	3.67	7.20	3.01
56	*Poa pratensis.* Blue grass	..do	8.97	4.98	4.51	9.03	2.70
52	*compressa.* English blue grass	..do	7.93	3.90	2.61	9.90	1.56
78	*Cinna arundinacea.* Reed grass		4.35	6.40	2.85	6.23	2.54
34	*Paspalum præcox*	Ala	11.49	6.56	3.19	7.39	1.90
73	*Elymus Canadensis.* Wild rye grass	Ind. T	6.45	5.60	3.47	5.56	1.47
66	*Aristida pupurascens.* Purple beard grass		6.60	6.40	2.42	5.22	3.42
71	*Sorghum nutaus*	Ind. T	5.22	4.94	2.41	6.12	3.26
	CARICÆ.						
68	*Scirpus eriophorum.* Wooly sedge grass	Ind. T	4.88	6.52	2.85	4.90	4.43
	HAY.						
85	Hay, cut before bloom	N. H	7.79	5.80	4.31	7.84	2.83
86	Hay, cut in full bloom	..do	7.45	4.66	4.22	5.81	.47
87	Hay, cut after bloom	..do	7.13	5.19	4.55	5.21	2.38

All "Minn." from Glenwood, Pope County.
All "N. H." from Manchester and Hanover (85). "Charlotte. Vt."
All "Ind. T." from Muscogee.
All "Ala." from Mobile.

of grasses and fodder plants, 1879.

Gum.	Starch isomers.	Undetermined, soluble in alkali.	Crude fiber.	Albumen, total, nitrogen, × 6.25.	Ash.	Wax.	Sugar.	Resin.	Gum.	Starch isomers.	Undetermined.	Crude fiber.	Albumen.
5.96	14.20	......	13.54	26.07	9.00	5.29	23.91	2.24	6.71	15.98	......	15.24	29.33
4.30	21.90	26.09	20.42	5.78	6.79	2.68	5.10	.18	4.67	23.78	28.34	22.18	6.28
5.22	13.79	16.28	20.24	9.80	7.49	4.46	13.78	3.38	5.66	14.96	17.67	21.96	10.64
5.50	13.50	20.73	27.97	5.00	8.35	3.09	6.24	4.07	5.87	14.41	22.13	29.86	5.98
2.70	17.82	8.50	16.60	19.08	15.02	5.77	7.82	2.49	2.87	18.98	9.05	17.68	20.32
2.30	21.93	10.50	20.82	12.25	6.34	3.73	14.11	1.67	2.52	23.98	11.48	22.77	13.40
......	......	......	......	......	......	......	......	......	......	......	......	......	......
4.72	21.60	10.56	17.99	11.90	9.74	3.57	8.46	1.80	5.40	24.72	12.09	20.59	13.62
1.90	20.88	17.98	21.60	7.00	7.12	4.08	10.45	1.95	2.09	23.00	19.81	23.79	7.71
2.62	21.70	7.82	21.76	11.00	8.53	4.16	13.44	1.80	2.91	24.10	8.68	24.16	12.22
3.14	6.30	21.14	21.22	9.77	11.17	3.01	10.89	5.10	3.56	7.14	23.98	24.07	11.08
1.10	6.45	28.69	24.35	8.31	14.29	2.52	3.07	3.55	1.22	7.17	31.88	27.06	9.24
2.28	10.86	26.08	26.57	7.14	6.98	2.15	9.54	1.98	2.49	11.81	28.37	28.91	7.77
1.70	19.48	19.43	26.89	6.65	5.59	3.89	11.87	.78	1.78	20.46	20.41	28.24	6.98
1.56	7.20	31.08	27.00	6.20	10.13	3.55	2.70	3.88	1.70	7.84	34.06	29.43	6.76
2.04	21.42	17.48	29.37	5.60	6.69	5.69	5.87	1.97	2.14	22.52	18.37	30.86	5.89
2.14	7.00	34.79	24.62	5.11	9.05	1.83	4.15	1.67	2.42	7.92	39.34	27.84	5.78
1.26	23.75	15.04	27.32	4.81	5.49	3.33	11.77	2.50	1.34	25.31	16.03	29.11	5.12
.86	21.85	18.09	30.35	2.63	4.57	2.98	10.26	3.79	.91	23.22	19.22	32.25	2.80
2.90	20.99	15.21	18.05	10.68	9.32	3.52	10.50	3.73	3.12	22.57	16.35	19.41	11.48
3.48	8.85	12.46	33.46	9.77	14.64	3.12	6.5	....	3.88	9.85	13.87	37.24	10.87
2.60	27.90	14.78	23.32	6.13	10.42	2.49	5.92	2.13	2.75	29.51	15.63	24.66	6.48
2.38	22.50	12.84	22.32	9.89	9.13	3.28	9.87	1.74	2.59	24.45	13.94	24.25	10.75
1.64	....	60.81		5.95	5.03	4.26	10.34	5.35	1.80	....	60.69	....	6.53
1.60	23.67	14.45	24.40	9.28	7.22	3.42	8.37	3.41	1.69	25.02	15.27	25.79	9.81
1.68	18.30	22.23	21.65	6.13	6.55	2.96	12.28	4.22	1.78	19.34	23.50	22.89	6.48
1.44	22.51	19.66	25.35	4.55	5.20	3.40	10.02	2.50	1.55	24.16	21.09	27.20	4.88
1.14	21.14	15.19	26.22	8.75	6.19	3.20	10.06	2.63	1.23	22.74	16.34	28.20	9.41
1.10	23.75	23.85	24.19	7.69	7.30	2.20	5.24	....	1.16	25.13	25.24	25.60	8.13
1.64	21.70	19.04	20.35	7.70	6.80	2.91	11.12	3.14	1.77	23.43	20.55	21.97	8.31
1.00	24.00	18.14	25.05	8.38	4.96	4.00	8.98	2.09	1.04	25.07	18.95	26.16	8.75
3.02	27.90	15.60	20.80	7.88	7.81	3.12	5.40	2.78	3.29	30.38	16.99	22.65	8.58
2.40	23.45	13.95	23.71	7.87	8.43	3.41	8.62	1.89	2.61	25.79	15.18	25.21	8.56
2.74	22.19	12.24	23.35	7.88	8.44	3.49	9.77	5.31	2.92	23.68	13.07	24.91	8.41
2.20	22.20	16.14	23.42	7.35	5.09	3.02	10.30	3.48	2.41	24.32	17.68	25.65	8.05
1.60	25.70	21.59	24.17	4.90	7.86	2.10	4.01	1.34	1.74	27.92	23.45	26.26	5.32
1.06	18.32	22.76	29.03	3.68	4.08	3.19	9.52	2.83	1.14	19.67	24.44	31.18	3.95
1.66	7.20	34.87	26.27	5.83	7.11	1.85	4.72	2.41	1.84	7.97	38.58	29.07	6.45
1.04	22.42	22.55	27.75	3.85	4.46	3.19	8.28	.61	1.12	24.11	24.25	29.84	4.14
1.10	6.60	36.86	27.05	5.25	3.74	2.54	4.64	4.61	1.21	7.26	40.51	29.75	5.77
1.62	26.30	25.43	23.80	3.50	3.63	3.06	3.99	3.28	1.73	28.06	27.13	25.39	3.73
1.24	21.37	20.05	27.87	7.70	5.16	3.71	7.59	1.75	1.30	22.34	20.96	29.14	8.05
.74	23.47	18.73	28.03	7.38	3.57	3.52	8.17	....	.80	25.39	20.25	30.32	7.98
1.74	27.70	15.40	28.15	5.60	4.38	3.80	7.45	3.11	1.79	28.64	15.93	29.11	5.79
1.66	20.90	19.97	20.45	6.83	5.47	4.95	9.92	2.97	1.82	22.96	21.94	22.47	7.50
11.48	23.45	14.20	19.20	5.77	4.24	2.84	10.75	1.69	12.47	25.47	15.42	20.85	6.27
6.12	20.42	16.79	28.35	5.95	6.69	2.98	6.51	2.66	6.40	21.35	17.55	29.64	6.22
1.80	7.65	32.37	22.40	5.25	7.41	3.60	8.35	2.14	2.03	8.64	36.59	25.31	5.93
4.06	19.11	17.31	32.42	4.55	5.99	3.71	5.94	1.57	4.34	20.43	18.50	34.66	4.86
1.54	27.20	19.92	23.25	4.03	6.85	2.59	5.59	3.66	1.65	29.12	21.33	24.89	4.32
1.88	22.50	22.87	27.12	3.68	5.21	2.54	6.46	3.44	1.98	23.74	24.13	28.62	3.88
.90	22.57	22.37	28.72	4.41	6.86	3.00	5.15	4.66	.95	23.73	23.52	30.19	4.64
3.32	22.02	14.36	20.10	11.63	6.29	4.67	8.50	3.07	3.60	23.88	15.58	21.80	12.61
3.14	35.83	....	31.21	8.63	5.04	4.56	6.28	.51	3.39	38.71	....	33.72	9.32
3.90	29.91	8.11	24.18	9.44	5.59	4.90	5.61	2.56	4.20	32.21	8.73	26.04	10.16

TABLE II.—*Amount of nitrogen, and its solubility, in grasses and fodder plants.*

Number of analysis.	Genus and species.	Locality.	Total nitrogen.	Nitrogen, insoluble in 80 per cent. alcohol.	Soluble nitrogen.	Per cent. of total nitrogen soluble.	Total nitrogen × 6.25.	Insoluble N. × 6.25 or albuminoids.	Per cent. of moisture in substance, as experimented on.	Total nitrogen × 6.25 on dry substance.	Insoluble N. × 6.25 on dry substance.
67	*Andropogon argenteus.* Silver beard grass	Ind. T	.56	.22	.34	60.7	3.50	1.38	6.27	3.74	1.47
75	*scoparius.*	Ind. T	.62	.25	.37	59.7	3.88	1.56	7.00	4.17	1.68
16	*Cynodon dactylon.* Bermuda grass	Wis	1.52	.62	.90	59.2	9.50	3.88	11.19	10.70	4.37
74	*Spartina cynosuroides.* Whip grass	Ind. T	.73	.31	.42	57.5	4.56	1.94	6.80	4.87	2.08
76	*Panicum capillare.* Witch grass	Ind. T	1.06	.45	.61	57.5	6.63	2.81	4.78	6.98	2.95
58	*Andropogon macrourus.* Broom grass	Ala	.84	.36	.48	57.1	5.25	2.25	9.02	5.77	2.47
29	*scaparius.* Broom grass	Ala	.83	.36	.47	56.6	5.19	2.25	8.02	5.64	2.45
77	*furcatus*	Ind. T	.59	.28	.31	52.5	3.69	1.75	6.88	3.93	1.88
71	*Sorghum nutaus*	Ind. T	.59	.28	.31	52.5	3.69	1.75	5.22	3.90	1.84
11	*Eleusina Indica.* Yard grass, crow-foot	Tex	1.99	.95	1.04	52.2	12.44	5.94	8.58	13.61	6.60
23	*Panicum jumentorum*	Ala	1.29	.62	.67	52.0	8.06	3.88	9.41	8.90	4.28
62	*Scirpus eriophorum.* Wooly sedge grass	Ind. T	.70	.34	.36	51.4	4.38	2.13	3.64	4.67	2.21
40	*Panicum virgatum.* Tall prairie grass	Ind. T	.77	.39	.38	49.2	4.81	2.44	6.15	5.14	2.60
6	*Tricuspis sesleroides*	Tex	.94	.48	.46	48.9	5.88	3.00	6.95	6.32	3.22
72	*purpurea.* Purple tricuspus	Ind. T	1.23	.64	.59	48.0	7.69	4.00	4.35	8.04	4.18
7	*Leptochloa mucronata.* Feather grass	Tex	1.13	.59	.54	47.8	7.06	3.69	7.92	7.67	4.01
79	*Panicum virgatum.* Tall panic grass	Ind. T	.42	.22	.20	47.6	2.63	1.38	5.90	2.77	1.47
1	*Paspalum laeve.* Water grass	Tex	1.20	.63	.57	47.5	7.50	3.94	7.15	8.08	4.24
78	*Cinna arundinacea.* Reed grass	Ind. T	.95	.50	.45	47.4	5.94	3.18	4.35	6.24	3.32
55	*Bromus secalinus.* Common cheat or chess	N. H	1.12	.70	.52	46.4	7.00	4.38	9.22	7.71	4.82
31	*Eleusina Indica.* Yard grass, crow-foot grass	Ala	1.62	.87	.75	46.3	10.13	5.44	8.29	11.05	5.93
37	*Panicum dichotomum*	Ala	.98	.53	.45	45.9	6.13	3.31	8.41	6.76	3.61
51	*Festuca pratensis.* Field fescue	N. H	1.58	.87	.71	44.9	9.88	5.44	7.97	10.73	5.91
65	*Richardsonia scabra.* Mexican clover	Ala	.90	.50	.40	44.4	5.63	3.18	6.34	5.99	3.40
45	*Bromus unioloides.* Schrader's grass	Grounds	1.90	1.06	.84	44.2	11.88	6.63	12.63	13.56	7.59
43	*Panicum gibbum*	Ala	1.76	1.01	.75	42.6	11.00	6.31	9.95	12.04	7.01
21	*virgatum.* Tall prairie switch grass	Ala	.67	.39	.28	41.8	4.19	2.44	8.35	4.58	2.66
4	*Sorghum nutans.* Wood grass	Tex	.48	.28	.20	41.2	3.00	1.75	6.54	3.21	1.87
5	*Setaria setosa.* Bristle grass	Tex	1.25	.73	.51	41.1	7.81	4.56	8.24	8.47	4.97
70	*Panicum agrostoides.* Marsh panic	Ind. T	.90	.53	.37	41.1	5.63	3.31	4.87	5.88	3.48
20	*Sorghum halapense.* Johnson grass	Ala	1.73	1.04	.69	40.0	10.81	6.50	8.11	13.18	7.07
12	*Muhlenbergia diffusa.* Drop seed grass	Tex	1.48	.90	.58	39.2	9.25	5.63	7.21	10.06	6.07
26	*Eleusina Indica.* Yard grass, crow-foot grass	Ga	1.78	1.09	.69	38.7	11.13	6.81	8.35	13.28	7.43
73	*Elymus Canadensis.* Wild rye grass	Ind. T	.73	.45	.28	38.3	4.56	2.81	6.45	4.86	3.00
50	*Anthoxanthon odoratum.* Vernal grass	N. H	1.26	.78	.48	38.1	7.88	4.88	8.08	8.56	5.31
19	*Hierochloa borealis.* Vanilla grass	Ills	2.07	1.29	.78	37.7	12.94	8.06	8.69	14.31	8.83

3	*Panicum Texanum.* Texas millet	Tex	.80	.50	.30	37.5	5.00	3.18	8.15	5.47	3.46
59	*Andropogen furcatus.* Blue joint	Nebr	.80	.50	.30	37.5	5.00	3.18	7.95	5.34	3.45
60	*Muhlenbergia, sp.?* Knot grass	N. H	1.96	1.23	.73	37.2	12.25	7.69	8.56	13.39	3.41
25	*Cynodon dactylon.* Bermuda grass	Ala	1.97	1.26	.71	36.0	12.31	7.88	8.14	13.59	8.58
40	*Panicum Crusgalli.* Barn yard grass	Ala	1.15	.73	.42	36.5	7.19	4.56	8.08	7.73	4.95
39	*proliferum.* Large crab grass	Ala	1.57	1.01	.56	35.7	9.81	6.31	11.83	11.04	7.16
61	*Plantago lanceolata.* Ribwort plantain	N. H	1.57	1.01	.56	35.7	9.81	6.31	7.85	10.63	6.84
27	*Dactyloctenium ægyptiacum.* Crow-foot grass	Ga	1.16	.76	.40	34.4	7.25	4.75	9.82	9.01	5.27
53	*Glyceria nervata.* Fowl meadow grass	N. H	1.23	.81	.42	34.1	7.69	5.06	7.36	8.32	5.46
46	*Andropogen furcatus.* Blue joint grass	Minn	1.18	.78	.40	33.9	7.38	4.88	8.70	8.08	5.34
48	*Spartina cynosuroides.* Marsh grass	Minn	1.48	.98	.50	33.8	9.25	6.19	5.28	9.84	6.54
44	*Vicia sativa.* Common vetch	Grounds	4.17	2.80	1.37	32.8	26.06	17.50	11.12	29.08	19.60
52	*Poa compressa.* English blue grass	N. H	.92	.62	.30	32.6	5.75	3.88	7.93	6.29	4.21
22	*Panicum sanguinale.* Crab grass	Ala	1.41	.95	.46	32.6	8.81	5.94	9.98	9.99	6.65
64	*Danthonia spicata.* Wild oat grass	N. H	.90	.62	.28	31.1	5.63	3.88	3.29	5.79	4.01
32	*Dactylis glomerata.* Orchard grass	N. H	1.26	.87	.39	30.9	7.86	5.44	6.28	8.41	5.80
56	*Poa pratensis.* Blue grass	N. H	1.09	.76	.33	30.3	6.81	4.75	8.97	7.51	5.22
66	*Aristida purpurascens.* Purple beard grass	Ind. T	.64	.45	.19	29.7	4.00	2.81	6.60	4.31	3.01
17	*Sporobolus Indicus.* Smut grass	Wis	1.81	1.29	.52	28.7	11.31	8.06	8.24	12.43	8.78
49	*Muhlenbergia glomerata.* Satin grass	Minn	3.05	2.18	.87	28.5	19.06	13.63	6.10	20.22	14.52
69	*Uniola latifolia.* Fescue grass	Ind. T	.98	.70	.28	28.5	6.19	4.38	5.46	6.40	4.63
18	*Tripsacum dactyloides.* Gamma grass	Wis	1.27	.92	.35	27.6	7.91	5.75	7.98	8.62	6.27
57	*Echium vulgare.* Blue weed, blue thistle	W. Va	.92	.67	.25	27.2	5.75	4.19	7.92	6.24	4.55
16	*Poa pratensis.* June grass, blue grass	Wis	1.64	1.20	.44	26.8	10.25	7.50	10.92	11.51	8.42
15	*Agrostis exarata.* Native red top	Wis	1.52	1.12	.40	26.3	9.50	7.00	10.60	10.65	7.83
34	*Paspalum præcox*	Ala	.84	.62	.22	26.2	5.25	3.88	11.49	5.93	4.38
53	*Spartina cynosuroides.* Marsh or whip grass	Ills	.98	.73	.25	25.5	6.13	4.56	5.40	6.40	4.82
14	*Poa serotina.* Fowl meadow grass	Wis	1.27	.95	.32	25.2	7.94	5.94	10.80	8.91	6.62
41	*Andropogon scoparius* (before bloom)	Ala	.93	.70	.23	24.7	5.81	4.38	9.62	6.47	4.84
36	*Panicum divaricatum*	Ala	1.34	1.01	.33	24.6	8.38	6.31	10.02	9.22	7.01
63	*Triticum repens.* Quick grass	N. H	1.71	1.29	.42	24.5	10.69	8.06	7.00	11.43	8.67
2	*Andropogon Virginicus.* Brown ledge grass	Tex	.45	.34	.11	24.4	2.81	2.13	6.46	3.01	2.28
10	*Panicum Crusgalli* (var.?) Barn yard grass, cock's foot	Tex	.59	.45	.14	23.7	3.69	2.81	7.88	4.14	3.65
9	*virgatum.* Tall panic or switch grass	Tex	.73	.56	.17	23.3	4.56	3.50	7.69	5.01	3.79
81	*Danthonia compressa.* Wild oat grass	Vt	1.18	.87	.31	22.9	7.38	5.44	7.55	7.97	5.88
82	*Glyceria aquatica.* Reed meadow grass	Vt	1.23	.95	.28	22.7	7.69	5.94	5.50	7.92	6.28
83	*nervata*	Vt	1.40	1.09	.31	22.1	8.75	6.81	7.05	9.32	7.33
42	*Uniola latifolia* (1878). Fescue grass	Ala	1.57	1.23	.34	21.6	9.81	7.69	10.16	10.92	8.56
85	Hay, cut before bloom	N. H	1.86	1.46	.40	21.5	11.63	9.13	7.79	12.61	9.90
20	*Bromus catharticus.* Cal. brome grass	Ills	1.46	1.15	.31	21.2	9.13	7.19	8.13	9.93	7.83
35	*Panicum anceps*	Ala	.81	.64	.17	21.0	5.06	4.00	11.57	5.72	4.52
21	*Lespedeza striata.* Japan clover	Ala	2.19	1.76	.43	19.6	13.69	11.00	9.13	15.06	12.11
87	Hay, cut after bloom	N. H	1.51	1.23	.28	18.5	9.44	7.69	7.13	10.16	8.28
33	*Desmodium molle.* Beggar lice	S. C	272	2.27	.45	16.5	17.00	14.18	10.45	21.22	15.83
28	Name unknown	Ga	.76	.67	.09	11.8	4.75	4.19	8.15	5.61	4.56
86	Hay, in bloom	N. H	1.38	1.25	.13	9.4	8.63	7.83	7.45	9.32	8.46
47	*Bouteloua oligostachya.* Gamma grass	Minn	1.26	1.15	.11	8.7	7.88	7.19	7.39	8.51	7.76
8	*Panicum obtusum*	Tex	1.06	1.01	.05	4.7	6.63	6.31	8.10	7.27	6.87
84	*Avena striata.* Mountain oat grass	Vt	1.34	1.34	....	0.0	8.38	8.38	4.25	8.75	8.75
32	*Panicum filiforme*	Ala	.48	.50	....	0.0	3.00	3.13	7.77	3.32	3.45
....	Average per cent. of total nitrogen soluble	....	....	....	....	31.7	....	....	....	....	....

TABLE II.—*Amount of nitrogen and its solubility in sugar plants, &c.*

Number of analysis.	Varieties.	Locality.	Total nitrogen.	Nitrogen, insoluble in 80 per cent. alcohol.	Soluble nitrogen.	Per cent. of total nitrogen soluble.	Total nitrogen × 6.25	Insoluble N. × 6.25 or albuminoids.	Per cent. of moisture in substance, as experimented on.	Total nitrogen × 6.25 on dry substance.	Insoluble N. × 6.25 on dry substance.
1	Early amber stalk, unpressed	....	.69	.28	.41	59.4	4.31	1.75	10.85	5.05	1.96
2	Honduras stalk, unpressed	....	1.01	....	....	....	6.31	....	8.71	4.80	....
3	Egyptian sugar corn, unpressed	....	.70	.42	.28	40.0	4.38	2.62	11.79	6.93	2.97
4	Early amber bagasse	....	.57	....	....	....	3.56	....	7.21	3.97	....
5	Honduras bagasse	....	.59	.28	.31	52.5	3.69	1.75	7.02	3.87	1.88
6	Egyptian sugar corn bagasse	....	.91	.62	.29	31.9	5.69	3.88	5.73	6.03	4.12
7	Early amber leaves	....	1.54	1.26	.28	18.3	9.63	7.88	6.67	10.32	8.44
8	Honduras leaves	....	1.96	1.01	.95	48.5	12.25	6.31	6.79	13.14	6.77
9	Egyptian sugar corn leaves	....	1.68	.39	1.29	76.8	10.50	2.44	7.48	11.36	2.64
10	Chinese sorghum seeds	....	1.60	.87	.73	45.6	10.00	5.44	9.93	11.10	6.04
11	Early amber seeds	....	1.53	.63	.90	58.8	9.56	3.94	10.57	10.69	4.41
173	Chinese corn seeds	....	1.54	.63	.91	60.0	9.63	3.94	7.87	10.45	4.28
174	Brown doura seeds	....	1.44	.36	1.08	75.0	9.00	2.25	7.62	9.74	2.43
12	Ribbon cane bagasse, butt	....	.39	.20	.19	49.0	2.44	1.25	....	....	....
13	Ribbon cane bagasse, middle	....	.39	.25	.14	35.9	2.44	1.56	....	....	....
161	Fulz wheat, whole grain	....	1.96	1.09	.87	44.4	12.25	6.81	10.40	13.67	7.60
162	outer coat removed	....	2.03	1.12	.91	44.8	12.68	7.00	10.60	14.18	7.83
163	outer coat	....	1.04	.67	.37	35.6	6.50	4.19	8.93	7.13	4.60
109	Rangoon rice	....	1.18	1.09	.09	7.6	7.38	6.81	13.45	8.[illegible]3	7.69
110	Bassein India rice	....	1.34	1.29	.05	3.7	8.38	8.06	11.38	9.[illegible]5	9.69

TABLE III.—*Analysis of grasses and fodder plants made in 1878, 1879, and 1880.*

Numbers.		Locality.	Water.	Ash.	Fat.	N. free extract.	Crude fiber.	Nitrogen × 6.25.	Ash.	Fat.	N. free extract.	Crude fiber.
	LEGUMINOSÆ.											
44	*Vicia sativa.* Common vetch	Grounds	11.12	8.00	4.70	36.57	13.54	26.07	9.00	5.29	41.14	15.24
33	*Desmodium molle.* Beggar lice	S. C.	10.45	6.95	2.49	40.44	22.69	16.98	7.76	2.78	45.16	25.34
21	*Lespedeza striata.* Japan clover	Ala	9.13	4.11	3.99	47.52	21.55	13.70	4.52	4.39	52.30	23.71
	MISCELLANEOUS PLANTS.											
57	*Echium vulgare.* Blue weed, blue thistle	W. Va	7.92	6.25	2.47	57.16	20.42	5.78	6.79	2.68	62.07	22.18
61	*Plantago lanceolata.* Ribwort plantain	N. H	7.85	6.90	4.11	51.10	20.24	9.80	7.49	4.46	55.45	21.96
65	*Richardsonia scabra.* Mexican clover	Ala	6.34	7.82	2.89	49.38	27.97	5.60	8.35	3.09	52.72	29.86
	GRAMINEÆ.											
49	*Muhlenbergia glomerata.* Satin grass	Minn	6.10	14.10	5.42	38.70	16.60	19.08	15.02	5.77	41.21	17.68
60	sp? Knot grass	N. H	8.56	5.80	3.41	49.16	20.82	12.25	6.34	3.73	53.76	22.77
12	*diffusa.* Drop seed grass	Tex	7.21	8.61	1.68	51.36	21.86	9.28	9.28	1.81	55.35	23.56
88	*Phalaris angusta.* American canary grass	S. C	7.84	10.75	3.75	40.03	22.89	14.70	11.66	4.11	43.44	24.84
19	*Hœrochlva borealis.* Vanilla grass	Ill	8.69	8.51	3.72	45.15	21.02	12.91	9.32	4.06	49.45	23.02
45	*Bromus unioloides.* Schrader's grass	Grounds	12.63	8.51	3.12	45.85	17.99	11.90	9.74	3.58	52.47	20.59
20	*carinatus.* California broom grass	Ill	8.13	10.00	2.46	45.74	24.56	9.11	10.88	2.68	49.79	26.73
55	*secalina.* Common cheat or chess	N. H.	9.22	6.46	3.70	52.02	21.60	7.00	7.12	4.08	57.30	23.79
11	*Eleusina Indica.* Yard grass, crow-foot grass	Tex	8.58	17.59	1.96	31.09	28.35	12.43	19.24	2.14	34.01	31.01
26	*Indica.* Yard grass, crow-foot grass	Ga	8.35	7.55	1.91	50.47	20.61	11.11	8.24	2.08	55.07	22.49
31	*Indica.* Yard grass, crow-foot grass	Ala	8.29	8.91	2.32	50.87	19.47	10.14	9.71	2.53	55.47	21.23
25	*Cynodon dactylon.* Bermuda grass	Ala	8.14	8.37	1.44	48.33	21.39	12.33	9.11	1.57	52.61	23.29
16	*dactylon.* Bermuda grass	Miss	11.19	8.80	1.89	47.74	20.89	9.49	9.91	2.13	53.75	23.52
17	*Sporobolus Indicus.* Smut grass	Miss	8.24	6.46	3.00	47.41	23.56	11.33	7.04	3.27	51.67	25.67
43	*Panicum gibbum*	Ala	9.95	7.68	3.75	45.86	21.76	11.00	8.53	4.16	50.93	24.16
39	*proliferum.* Very ripe and rank	Ala	11.83	9.85	2.65	44.68	21.22	9.77	11.17	3.01	50.67	24.07
22	*sanguinale.* Crab grass	Ala	9.98	11.35	2.54	38.44	28.89	8.80	12.61	2.82	42.70	32.09
36	*divaricatum*	Ala	10.02	12.86	2.27	42.19	24.35	8.31	14.29	2.52	46.89	27.06
23	*jumentorum*	Ala	9.41	8.19	1.42	44.37	28.56	8.05	9.04	1.57	48.98	31.52
40	*Crusgalli.* Barn-yard grass	Ala	8.08	6.42	1.98	49.81	26.57	7.14	6.98	2.15	54.19	28.91
10	*Crusgalli.* Barn-yard grass, cock's foot	Tex	7.88	14.80	1.88	43.08	28.68	3.68	16.07	2.04	46.77	31.13
8	*obtusum*	Tex	8.10	10.06	2.07	42.68	30.44	6.65	10.95	2.25	46.44	33.12

TABLE III.—*Analysis of grasses and fodder plants made in 1878, 1879, and 1880*—Continued.

Numbers.		Locality.	Water.	Ash.	Fat.	N. free extract.	Crude fiber.	Nitrogen × 6.25.	Ash.	Fat.	N. free extract.	Crude fiber.
76	*Panicum capillare.* Witch grass	Ind. T	4.78	5.32	3.70	52.66	26.89	6.65	5.59	3.89	55.30	28.24
57	*dichotomum*	Ala	8.41	9.28	3.25	45.86	27.00	6.20	10.13	3.55	50.07	29.48
30	*agrostoides.* March panic	Ind. T	4.87	6.38	5.41	48.39	29.37	5.60	6.69	5.69	50.87	30.86
35	*anceps*	Ala	11.57	8.00	1.62	49.08	24.62	5.11	9.05	1.83	55.50	27.84
3	*Texanum.* Texas millet	Tex	8.15	9.28	2.27	50.45	24.82	5.03	10.10	2.47	54.93	27.02
80	*virgatum*, short. Tall panic grass	Ind. T	6.15	5.15	3.12	53.45	27.32	4.81	5.49	3.33	56.95	29.11
9	*virgatum.* Tall panic or switch grass	Tex	7.69	6.68	1.54	45.59	33.95	4.55	7.24	1.66	49.39	36.78
24	*virgatum.* Tall panic, switch grass	Ala	8.35	3.43	1.76	55.86	26.41	4.19	3.74	1.92	60.95	28.82
79	*virgatum*, tall. Tall panic grass	Ind. T	5.90	4.30	2.80	54.02	30.35	2.63	4.57	2.98	57.40	32.25
52	*filiforme*	Ala	7.77	8.08	1.37	56.52	23.83	2.73	8.76	1.48	60.95	25.83
10	*Sorghum halepense.* Johnson's grass	Ala	8.11	7.42	2.61	48.01	23.01	10.84	8.07	2.84	52.24	25.65
71	*nutans*	Ind. T	5.22	4.94	2.41	56.63	27.12	3.68	5.21	2.54	59.75	28.62
4	*nutans.* Wood grass	Tex	6.54	8.57	1.52	47.03	33.35	2.99	9.17	1.63	50.32	35.68
13	*Poa pratensis.* Juno grass, blue grass	Wis	10.92	4.63	2.55	46.73	24.89	10.28	5.20	2.86	52.46	27.94
56	*pratensis.* Blue grass	N. H	8.97	4.98	4.51	54.26	20.45	6.83	5.47	4.95	59.61	22.47
72	*serotina.* English blue grass	N. H	7.93	3.90	2.61	60.59	19.20	5.77	4.23	2.84	65.81	20.85
14	*compressa.* Fowl meadow grass	Wis	10.30	4.67	3.09	51.29	22.74	7.91	5.21	3.44	57.18	25.35
43	*Triticum repens.* Quick grass	N. H	7.00	8.67	3.27	52.33	18.05	10.68	9.32	3.52	56.27	19.41
42	*Uniola latifolia.* Fescue grass	Ala	10.16	13.15	2.80	30.66	33.46	9.77	14.64	3.12	34.13	37.24
69	*latifolia.* Fescue grass	Ind. T	5.46	9.85	2.35	52.89	23.32	6.13	10.42	2.49	55.95	24.66
51	*Festuca pratensis.* Field fescue	N. H	7.97	8.40	3.02	48.40	22.32	9.89	9.13	3.28	52.59	24.25
54	*ovina.* Sheep fescue	N. H	8.82	4.59	3.88	76.76		5.95	5.03	4.26	84.18	
15	*Agrostis exarata.* Native red top	Wis	10.60	5.32	2.06	50.62	21.91	9.49	5.95	2.29	56.63	24.51
48	*Spartina cynosuroides.* Marsh grass	Grounds	5.38	6.83	3.24	50.87	24.40	9.28	7.22	3.42	53.76	25.79
78	*cynosuroides.* Marsh or whip grass	Ill	5.40	6.20	2.80	57.82	21.65	6.13	6.55	2.96	61.12	22.89
74	*cynosuroides.* Whip grass	Ind. T	6.80	4.85	3.17	55.28	25.35	4.55	5.20	3.40	59.32	27.29
13	*Glyceria nervata*	Vt	7.05	7.75	2.97	49.26	26.22	8.75	6.19	3.20	53.00	28.20
82	*aquatica.* Reed meadow grass	Vt	5.50	6.90	2.57	53.65	24.19	7.69	7.30	2.20	56.77	25.60
83	*nervata.* Fowl meadow grass	N. H	7.36	6.30	2.70	55.59	20.35	7.70	6.80	2.91	60.01	21.97
64	*Avena striata.* Mountain oat grass	Vt	4.25	4.75	3.83	53.74	25.05	8.38	4.96	4.00	56.13	16.16
18	*Tripsacum dactyloides.* Yama grass	Miss	7.98	5.69	2.20	51.82	24.40	7.91	6.19	2.39	56.31	26.51
47	*Bouteloua oligostachya.* Gamma grass	Grounds	8.15	7.17	2.87	53.13	20.80	7.88	7.81	3.12	57.84	22.65
59	*Anthoxanthum odoratum.* Vernal grass	N. H	8.08	7.75	3.13	49.46	23.71	7.87	8.43	3.14	53.81	25.79
5	*Setaria setosa.* Bristle grass	Tex	8.24	8.33	1.37	44.63	29.64	7.79	9.08	1.49	48.61	32.30
62	*Dactylis glomerata.* Orchard grass	N. H	6.28	7.91	3.27	51.31	23.35	7.88	8.44	3.49	54.75	24.91
1	*Paspalum laeve.* Water grass	Tex	7.15	7.12	2.55	50.01	25.64	7.53	7.70	2.75	53.83	27.61

34	*præcox*	Ala	11.49	6.56	3.19	51.11	22.40	5.25	7.41	3.60	57.75	25.31
40	*Andropogon furcatus.* Blue-joint grass	Grounds	8.70	4.65	2.76	53.12	23.42	7.35	5.09	3.02	58.19	25.65
59	*furcatus.* Blue joint	Nebr	7.95	7.24	1.93	53.81	24.17	4.90	7.86	2.10	58.46	26.26
77	*furcatus*	Ind. T	6.88	3.80	2.97	53.64	29.03	3.68	4.08	3.19	57.60	31.18
41	*scoparius.* Before bloom	Ala	9.62	6.43	1.67	50.18	26.27	5.83	7.11	1.85	55.52	29.07
19	*scoparius.* Broom grass	Ala	8.02	5.37	1.45	57.29	22.67	5.20	5.84	1.58	62.29	24.64
75	*scoparius*	Ind. T	7.00	4.15	2.97	54.28	27.75	3.85	4.46	3.19	58.37	29.84
38	*macrourus.* Broom grass	Ala	9.02	3.40	2.31	52.97	27.05	5.25	3.74	2.54	58.20	29.75
67	*argenteus.* Silver beard grass	Ind. T	6.27	3.40	2.87	60.16	23.80	3.50	3.63	3.06	64.19	25.39
2	*Virginicus.* Broom-sedge, sedge grass	Tex	6.46	8.72	1.57	49.50	30.94	2.81	9.33	1.67	52.92	33.08
27	*Dactyloctenium ægyptiacum.* Crow-foot grass	Ga	9.82	6.40	1.75	59.14	15.63	7.26	7.10	1.94	65.58	17.33
72	*Tricuspis purpurea.* Purple tricaspis	Ind. T	4.35	4.95	3.55	51.53	27.87	7.70	5.16	3.71	53.94	29.14
6	*sesleroides*	Tex	6.95	4.77	1.85	45.47	35.10	5.86	5.13	1.99	48.86	37.72
61	*Danthonia compressa.* Wild-oat grass	Vt	7.55	3.30	3.25	50.49	28.03	7.38	3.57	3.52	54.61	30.32
64	*spicata.* Wild-oat grass	N. H	3.29	4.24	3.67	55.65	28.15	5.69	4.38	3.80	56.92	29.11
7	*Leptochloa mucronata.* Feather grass	Tex	7.92	10.82	1.89	43.05	29.23	7.09	11.76	2.05	46.75	31.74
78	*Cinna arundinacea.* Reed grass	Ind. T	4.35	6.40	2.85	52.10	28.35	5.95	6.69	2.98	54.47	29.64
73	*Elymus Canadensis.* Wild rye-grass	Ind. T	6.45	5.60	3.47	47.51	32.42	4.55	5.99	3.71	50.78	34.66
66	*Aristida purpurascens.* Purple beard grass	Ind. T	6.60	6.40	2.42	57.30	23.25	4.03	6.85	2.59	61.36	24.88
	CARICE.											
68	*Scirpus eriophorum.* Woolly sedge grass	Ind. T	4.86	6.52	2.85	52.62	28.72	4.41	6.85	3.00	55.32	30.19
	HAY.											
85	Hay cut before bloom { probably interchanged	N. H	7.79	5.80	4.31	50.37	20.10	11.63	6.29	4.67	54.63	21.80
86	Hay cut while in bloom } probably interchanged	N. H	7.45	4.66	4.22	43.83	31.21	8.63	5.04	4.56	47.36	33.72
87	Hay cut after bloom	N. H	7.13	5.19	4.55	49.51	24.18	9.44	5.59	4.90	53.31	26.01
90	Hay cut in bloom	N. H	11.84	4.37	4.80	49.59	22.22	7.38	4.97	5.38	56.08	25.20
91	Hay cut after bloom	N. H	10.83	4.37	4.60	50.48	22.91	6.81	4.90	5.25	53.26	28.95

TABLE III.—*Analysis of grasses and fodder plants made in 1878, 1879, and 1880*—Continued.

Number.		Locality.	Nitrogen, × 6.25.	Water.	Ash.	Fat.	Nitrogen, free extract.	Crude fiber.	Nitrogen, × 6.25, albuminoids.	Nutritive ratio.	Quality.	Value per ton of dry substance.	Value per ton as hay with 14.3 per cent. moisture.
	LEGUMINOSÆ.												
44	*Vicia sativa.* Common vetch	Grounds	29.33	14.30	7.71	4.53	35.26	13.06	25.14	1:1.24		28.97	24.83
33	*Desmodium molle.* Beggar lice	S. S.	18.96	14.30	6.65	2.38	38.70	21.72	16.25	1:2.5		21.02	18.01
21	*Lespedeza striata.* Japan clover	Ala	15.08	14.30	3.88	3.76	44.82	20.32	12.92	1:3.8		20.35	17.44
	MISCELLANEOUS PLANTS.												
57	*Echium vulgare.* Blue weed, blue thistle	W. Va	6.28	14.30	5.82	2.30	53.19	19.01	5.38	1:10.3		14.77	12.66
61	*Plantago lanceolata.* Ribwort plantain	N. H.	10.64	14.30	6.42	3.82	47.52	18.82	9.12	1:5.6		17.83	15.20
65	*Richardsonia scabra.* Mexican clover	Ala	5.98	14.30	7.16	2.65	45.18	25.59	5.12	1:9.3		13.40	11.48
	GRAMINEÆ.												
49	*Muhlenbergia glomerata.* Satin grass	Minn	20.32	14.30	12.87	4.94	35.32	15.15	17.42	1:2.3	Extra	23.13	19.82
60	sp? Knot grass	N. H.	13.40	14.30	5.43	3.20	46.07	19.52	11.48	1:4.3	....do	19.03	16.31
	diffusa. Drop seed grass	Tex	10.00	14.30	7.95	1.55	47.44	20.19	8.57	1:5.7	Very good	15.83	13.57
88	*Phalaris angusta.* American canary grass	S. C	15.95	14.30	9.99	3.52	37.23	21.29	13.67	1:3.0	Extra	19.49	16.70
19	*Hierochloa borealis.* Vanilla grass	Ill	14.15	14.30	7.99	3.48	42.38	19.73	12.12	1:3.8	....do	19.12	16.39
45	*Bromus unioloides.* Schrader's grass	Grounds	13.62	14.30	8.35	3.07	44.97	17.64	11.67	1:4.0	....do	18.77	16.08
20	*carinatus.* California broom grass	Ill	9.92	14.30	9.32	2.30	42.67	22.91	8.50	1:5.3	Average	15.48	13.27
55	*secalina.* Common cheat or chess	N. H.	7.71	14.30	6.10	3.49	49.11	20.39	6.61	1:8.2	....do	17.03	14.59
11	*Eleusina Indica.* Yard grass, crow-foot grass	Tex	13.60	14.30	16.49	1.83	29.15	26.58	11.65	1:2.6	Very good	13.41	11.49
26	*Indica.* Yard grass, crow-foot grass	Ga	12.12	14.30	7.06	1.78	47.20	19.27	10.39	1:4.7	Extra	17.39	14.90
31	*Indica.* Yard grass, crow-foot grass	Ala	11.06	14.30	8.32	2.17	47.54	18.19	9.48	1:5.2	Very good	16.99	14.56
25	*Cynodon dactylon.* Bermuda grass	Ala	13.42	14.30	7.81	1.34	45.09	19.96	11.50	1:4.0	Extra	17.62	15.10
16	*dactylon.* Bermuda grass	Miss	10.69	14.30	8.49	1.83	46.06	20.16	9.16	1:5.2	Very good	16.25	13.93
17	*Sporobolus Indicus.* Smut grass	Miss	12.35	14.30	6.03	2.80	44.28	22.00	10.59	1:4.4	Extra	17.35	14.87
43	*Panicum gibbum*	Ala	12.22	14.30	7.31	3.56	43.65	20.71	10.47	1:4.5	....do	18.08	15.49
39	*proliferum.* Very ripe and rank	Ala	11.08	14.30	9.58	2.58	43.42	20.63	9.40	1:4.8	Very good	16.59	14.22
22	*sanguinale.* Crab grass	Ala	9.78	14.30	10.81	2.42	30.59	27.50	8.38	1:4.7	Average	14.45	12.38
36	*divaricatum*	Ala	9.24	14.30	12.25	2.16	40.18	23.19	7.92	1:5.7	....do	14.51	12.43
23	*jumentorum*	Ala	8.89	14.30	7.75	1.34	41.98	27.01	7.62	1:5.7	....do	14.01	12.00
40	*Crusgalli.* Barn-yard grass	Ala	7.77	14.30	5.98	1.84	46.44	24.78	6.66	1:7.2	Fair	14.32	12.27
10	*Crusgalli.* Barn-yard grass, cock's foot	Tex	3.99	14.30	13.77	1.75	40.08	26.68	3.42	1:12.2	Poor	10.24	8.78
8	*obtusum*	Tex	7.24	14.30	9.38	1.93	39.80	28.38	6.21	1:6.7	Fair	12.93	11.08

76	*capillare.* Witch grass	Ind. T	6.98	14.30	4.89	3.34	47.39	24.20	5.98	1:8.5	....do	14.97	12.83
37	*dichotomum*	Ala	6.77	14.30	8.68	3.04	42.91	25.27	5.80	1:7.9	....do	13.89	11.90
70	*agrostoides.* March panic	Ind. T	5.89	14.30	5.73	4.88	43.59	26.45	5.05	1:9.6	....do	14.66	12.56
35	*anceps*	Ala	5.78	14.30	7.76	1.57	47.56	23.89	4.95	1:9.9	Poor	12.99	11.13
3	*Texanum.* Texas millet	Tex	5.48	14.30	8.65	2.12	47.07	23.16	4.70	1:10.5	....do	13.06	11.19
80	*virgatum,* short. Tall panic grass	Ind. T	5.12	14.30	4.70	2.85	48.81	24.95	4.39	1:11.8	....do	12.63	10.82
9	*virgatum.* Tall panic or switch grass	Tex	4.93	14.30	6.20	1.42	42.33	31.53	4.23	1:10.4	....do	11.43	9.80
24	*virgatum.* Tall panic, switch grass	Ala	4.57	14.30	3.20	1.65	52.23	24.70	3.92	1:13.8	....do	13.01	11.15
79	*virgatum,* tall. Tall panic grass	Ind. T	2.80	14.30	3.92	2.55	49.19	27.64	2.40	1:21.6	....do	11.91	10.21
32	*filiforme*	Ala	2.96	14.30	7.51	1.27	52.24	22.14	2.54	1:21.1	....do	11.65	9.98
30	*Sorghum halapense.* Johnson's grass	Ala	11.80	14.30	6.92	2.43	44.77	21.47	10.11	1:4.7	Extra	17.21	14.75
71	*nutans*	Ind. T	3.88	14.30	4.46	2.18	51.21	24.53	3.32	1:16.0	Poor	12.73	10.91
4	*nutans.* Wood grass	Tex	3.20	14.30	7.86	1.40	43.12	30.58	2.74	1:16.2	....do	10.37	8.79
13	*Poa pratensis.* June grass, blue grass	Wis	11.54	14.30	4.46	2.45	44.96	23.94	9.89	1:4.8	Very good	17.07	14.63
56	*pratensis.* Blue grass	N. H	7.50	14.30	4.69	4.24	57.08	19.26	6.43	1:8.6	Good	16.53	14.21
52	*serotina.* English blue grass	N. H	6.27	14.30	3.63	2.43	56.40	17.87	5.37	1:10.9	Fair	15.40	13.20
14	*compressa.* Fowl meadow grass	Wis	8.82	14.30	4.46	2.95	49.00	21.73	7.56	1:6.9	Average	16.25	13.94
63	*Triticum repens.* Quick grass	N. H	11.48	14.30	7.99	3.02	48.22	16.63	9.84	1:5.2	Extra	17.97	15.40
42	*Uniola latifolia.* Fescue grass	Ala	10.87	14.30	12.55	2.67	29.25	31.91	9.32	1:3.4	Very good	14.13	12.11
69	*latifolia.* Fescue grass	Ind. T	6.48	14.30	8.93	1.75	47.94	21.13	5.55	1:9.0	Poor	13.95	11.96
51	*Festuca pratensis.* Field fescue	N. H	10.75	14.30	7.83	2.81	45.07	20.78	9.21	1:5.2	Very good	16.91	14.49
54	*ovina.* Sheep fescue	N. H	6.53	14.30	4.31	3.65	72.14		5.60	....	Poor	....	......
15	*Agrostis exarata.* Native red top	Wis	10.61	14.30	5.10	1.97	48.53	21.01	9.09	1:5.6	Very good	16.71	14.32
48	*Spartina cynosuroides.* Marsh grass	Grounds	9.81	14.30	6.19	2.93	46.07	22.10	8.41	1:5.8	....do	16.41	14.06
58	*cynosuroides.* Marsh or whip grass	Ill	6.48	14.30	5.61	2.54	52.38	19.62	5.55	1:10	Fair	14.94	12.80
74	*cynosuroides.* Whip grass	Ind. T	4.88	14.30	4.46	2.91	50.84	23.31	4.18	1:12.8	Poor	13.85	11.87
83	*Glyceria nervata*	Vt	9.41	14.30	5.30	2.74	45.43	24.17	8.06	1:6.0	Average	15.90	13.68
82	*aquatica.* Reed meadow grass	Vt	8.13	14.30	6.26	1.89	48.64	21.94	6.97	1:7.3	....do	14.99	12.85
53	*nervata.* Fowl meadow grass	N. H	8.31	14.30	5.83	2.49	51.43	18.83	7.12	1:7.6	....do	15.99	13.70
84	*Avena striata.* Mountain oat-grass	Vt	8.75	14.30	4.25	3.43	48.10	22.42	7.50	1:6.9	....do	16.37	14.03
18	*Tripsacum dactyloides.* Yama grass	Miss	8.60	14.30	5.30	2.05	48.26	22.72	7.37	1:6.8	....do	15.35	13.15
47	*Boatelloua oligostachya.* Gamma grass	Grounds	8.58	14.30	6.69	2.67	49.58	19.41	7.35	1:7.1	....do	15.99	13.70
50	*Anthoxanthon odoratum.* Vernal grass	N. H	8.56	14.30	7.22	2.92	46.12	22.10	7.34	1:6.7	....do	15.57	13.34
5	*Setaria setosa.* Bristle grass	Tex	8.49	14.30	7.78	1.28	41.68	27.68	7.28	1:5.9	Fair	13.63	11.68
62	*Dactylis glomerata.* Orchard grass	N. H	8.41	14.30	7.23	2.99	46.92	21.35	7.21	1:7.0	Average	15.65	13.41
1	*Paspalum læve.* Water grass	Tex	8.11	14.30	6.60	2.36	46.13	23.66	6.95	1:7.0	....do	14.87	12.74
31	*præcox*	Ala	5.93	14.30	6.35	3.09	49.49	21.69	5.08	1:10.3	Fair	14.46	12.39
46	*Andropogon furcatus.* Blue-joint grass	Grounds	8.05	14.30	4.36	2.59	49.87	21.98	6.90	1:7.6	Average	15.62	13.39
59	*furcatus.* Blue joint	Nebr	5.32	14.30	6.74	1.80	50.10	22.50	4.56	1:11.4	Poor	13.26	11.36
77	*furcatus*	Ind. T	3.95	14.30	8.50	2.73	49.36	26.72	3.39	1:15.4	....do	12.85	11.01
41	*scoparius.* Before bloom	Ala	6.45	14.30	6.09	1.59	47.58	24.91	5.53	1:8.9	....do	13.44	11.52
29	*scoparius.* Broom grass	Ala	5.65	14.30	5.00	1.35	53.39	21.12	4.84	1:11.3	....do	13.74	11.78
75	*scoparius*	Ind. T	4.14	14.30	3.82	2.73	50.03	25.57	3.55	1:14.9	....do	13.09	11.22
38	*macrourus.* Broom grass	Ala	5.77	14.30	3.21	2.18	49.87	25.50	4.94	1:10.5	....do	13.79	11.82
67	*argenteus.* Silver beard grass	Ind. T	3.73	14.30	3.11	2.02	55.01	21.76	3.20	1:18.0	....do	13.57	11.63
2	*Virginicus.* Broom-sedge, sedge grass	Tex	3.00	14.30	8.00	1.43	45.35	28.35	2.57	1:18.2	....do	10.64	9.12
27	*Dactyloctenium Ægypticum.* Crow-foot grass	Ga	8.05	14.30	6.08	1.66	56.21	14.85	6.90	1:8.4	Average	16.05	13.75
72	*Tricuspis purpurea.* Purple tricuspis	Ind. T	8.05	14.30	4.42	3.18	46.23	24.97	6.90	1:7.2	....do	15.41	13.21
6	*sesleroides*	Tex	6.30	14.30	4.40	1.73	41.84	82.33	5.40	1:8.1	Poor	12.49	10.70
81	*Danthonia compressa.* Wild-oat grass	Vt	7.98	14.30	3.06	3.02	46.80	25.98	6.84	1:7.3	Average	15.35	13.15
64	*spicata* Wild-oat grass	N. H	5.79	14.30	3.75	3.26	48.78	24.95	4.96	1:10.5	Fair	14.36	12.31
7	*Leptochloa mucronata.* Feather grass	Tex	7.70	14.30	10.08	1.76	40.06	27.20	6.60	1:6.3	....do	13.17	11.29

TABLE III.—*Analysis of grasses and fodder plants made in 1878, 1879, and 1880*—Continued.

Number.		Locality.	Nitrogen, × 6.25.	Water.	Ash.	Fat.	Nitrogen-free extract.	Crude fiber.	Nitrogen, × 6.25, albuminoids.	Nutritive ratio.	Quality.	Value per ton of dry substance.	Value per ton as hay with 14.3 per cent. moisture.
	GRAMINEÆ—Continued.												
78	*Cinna arundinacea*. Reed grass	Ind. T	6.22	14.30	5.73	2.55	46.69	25.49	5.33	1:9.2	Fair	13.82	11.84
73	*Elymus Canadensis*. Wild rye-grass	Ind. T	4.86	14.30	5.13	3.18	43.52	29.70	4.17	1:11.2	Poor	12.79	10.96
66	*Aristida purpurascens*. Purple beard grass	Ind. T	4.82	14.30	5.87	2.22	52.59	21.82	3.79	1:14.8	....do	13.29	11.39
	CARICEÆ.												
63	*Scirpus eriophorum*. Wooly sedge-grass	Ind. T	4.64	14.30	5.87	2.57	47.41	25.37	3.93	1:12.6	Poor	12.87	11.03
	HAY.												
85	Hay cut before bloom... } probably interchanged.	N. H	12.61	14.30	5.39	4.00	46.82	16.88	10.81	1:4.7	Extra	19.18	16.44
86	Hay cut while in bloom. } probably interchanged.	N. H	9.82	14.30	4.32	3.91	40.59	23.99	7.98	1:5.6	Very good	15.83	13.57
87	Hay cut after bloom	N. H	10.16	14.20	4.79	4.20	45.69	22.81	8.71	1:5.7	....do	17.46	14.96
90	Hay cut in bloom	N. H	8.37	14.30	4.26	4.61	48.06	21.69	7.17	1:6.0	Average	17.92	15.35
91	Hay cut after bloom	N. H	7.64	14.30	4.20	4.50	45.64	21.81	6.55	1:7.6	....do	15.94	13.66

Finally, I desire to express my appreciation of the faithfulness and efficiency which have characterized the assistance I have received in the performance of this work from those engaged with me in the labors of this division.

Respectfully submitted.

PETER COLLIER,
Chemist.

Hon. WM. G. LE DUC,
Commissioner.

REPORT OF THE STATISTICIAN.

SIR: I have the honor to submit my report as Statistician of the Department of Agriculture.

The agricultural productions of the country, which in the year 1878 had grown to such proportions as to attract the attention of the civilized world, were exceeded by the production in 1879. The movement of population to the West and the activity of our people have rendered it almost impossible to keep fully abreast with the increase of our production, both in the cereals and live stock.

In the estimates submitted great care has been given to the compilation from the returns made by some four thousand correspondents; they comprise representatives in two-thirds the counties of the whole country, and while it is not claimed that they are exact as to the whole, it is claimed that they are for the proportion they represent, and experience yearly shows that the portions not represented hold about the same conditions of increase or decrease as those reported.

The area sown or planted in the different crops of this country has never been taken by any previous census, but I am happy to state that the omission of former investigations is to be remedied in the census to be taken in 1880, and arrangements have been made for a full and complete enumeration of the acres planted in each principal crop. With this additional light on the subject there is assured in the future a more complete and accurate estimate than was possible in the past.

THE CROPS OF 1879.

Corn.—The acreage planted in this crop was 3 per cent. more than in 1878. The spring was unfavorable in the New England States owing to cold and rainy weather; in the Southern and Western States the season at planting was favorable, but in the large corn-producing section, north of the Ohio River, the complaint of defective seed was almost universal, thus causing a large area to be replanted which was consequently late in maturing. During the summer drought prevailed to a disastrous extent in the South Atlantic States and in Louisiana and Texas; in fact the crop in the latter State was only one-half of the previous year. In all other parts of the country the summer was most propitious, particularly so in those States bordering on the Ohio River and west of the Mississippi.

The weather in the months of September and October was rather unfavorable in the largest corn-producing States, causing an imperfect ripening of the crop and resulting in a softening of the grain, thereby rendering it unmerchantable, and even in some places unfit for domestic

uses. The out-turn of the crop, however, showed it to be the largest ever produced and was 1,547,901,000 bushels. The price as returned by the producer was for the whole country an average of 37.5 cents per bushel against 31.8 cents in 1878. The aggregate value of the crop is $580,000,000 for 1879 against $441,000,000 in 1878.

Wheat.—The winter of 1878–'79 was a severe one, but the injuries to fall sown wheat were confined to the Southern States, where the covering of snow, so universal in the Northern States, was needed.

There was some increase in the area planted in fall sown wheat, but the great increase in the area of this crop was in those States where it is sown in the spring. The total increase of acreage was nearly 2 per cent. The conditions of the crop during growth were not so favorable as during the year previous, but, although short in straw, the out-turn of grain was larger.

In those States bordering on the Ohio River the result was in excess of anticipations, while in the large producing States of the Northwest the reverse was the case, and there the crop of 1879 did not more than equal that of 1878. The same causes for the partial failure of the spring wheat crop as were given in 1878, were given this year, viz, extreme heat just at maturing, drought, and chinch bugs. On the Pacific slope the crop is rather below that of 1878, both in quantity and quality. The total crop for the whole country is estimated at 448,756,000 bushels, which, assuming the population to be 48½ million persons, would give a product of 9.2 + bushels per capita; allowing 5.5 bushels for home consumption (seed and food), there would remain a surplus of about 182,000,000 bushels for export.

The average yield per acre was 13.7 + bushels, considerably larger than in the year 1878, and almost identical with that of 1877, which was the largest average since twenty years. This average of 13.7 + represents the average of all the States, and seems very low, but it must be borne in mind that in many sections of the country wheat is only sown for home use and to utilize fields too long planted in other crops; taking into consideration only those States where wheat is a leading crop, the average is very different, as for instance in Ohio, Michigan, Indiana, and Illinois the average yield per acre this year was rather more than 19 bushels, equal to the yearly average of France and more than the yield in England for this year. The price, as returned us, shows a great advance to the farmer since a year, and is for 1879 $1.11 per bushel against $0.78 in 1878, thus making a crop worth $497,000,000 against $326,000,000 last year.

Oats.—The product of oats for 1879 was less than that of either the two previous years, and was 363,761,000 bushels. The area planted was 4 per cent. less than the previous year. The spring was dry and cold, which with unfavorable conditions during the summer caused a crop 12 per cent. less than that of 1878. The price, however, was much higher, and was $0.33 per bushel against $0.24 last year, netting to the farmer a total of $120,533,000 against $101,900,000 in 1878.

Cotton.—The spring and summer months were not so favorable for cotton as last year. Drought was reported as very detrimental in all the South Atlantic States and Texas. The condition at no time was reported as high as in 1878, and from returns made November 1 and December 1 the crop was estimated at 5,261,202 bales; unusually favorable weather for growth, maturing, and picking continued, however, through the month of December, and added largely to the crop. Unlike corn and other farm crops, cotton, being perennial, continues to produce new flowers and fruit undiminished till the plant is killed by frost.

Tobacco.—The total product of the country is within a small percentage of that of 1878, the gain being chiefly in Kentucky, Tennessee, and Connecticut, and the most serious decline in Ohio and Missouri. The quality of the crop is somewhat better than that of last year, but the price shows little or no variation. The crop for 1879 is estimated at 391,278,350 pounds, valued at $22,727,524, against 392,546,700 pounds, valued at $22,137,428 in 1878.

Potatoes.—There was an increase in the area planted in potatoes of 3 per cent.; drought was prevalent in some sections of the country, but on the whole the season was favorable and the yield per acre was an average of 98 bushels, against 69 in 1878, and 94 in 1877. The total crop is estimated at 181 million bushels, valued at $79,000,000.

Other crops.—For details of other crops reference is made to the following tables:

Table showing the product of each principal crop of the several States named, the yield per acre, the total acreage, the average price in each State, and the value of each crop, for 1879.

Products.	Quantity produced in 1879.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MAINE.					
Indian corn .... bushels..	1,587,000	30	52,900	$0 76	$1,206,120
Wheat .... do....	488,000	16	30,500	1 44	702,720
Rye .... do....	46,800	18	2,600	96	44,928
Oats .... do....	3,087,000	30	102,900	43	1,327,410
Barley .... do....	937,500	25	37,500	80	750,000
Buckwheat .... do....	540,000	30	18,000	59	318,600
Potatoes .... do....	6,993,000	135	51,800	42	2,937,060
Hay .... tons..	1,247,400	1.14	1,094,211	9 22	11,501,028
Total	....	....	1,390,411	....	18,787,866
NEW HAMPSHIRE.					
Indian corn .... bushels..	1,859,000	32.5	57,200	78	1,450,020
Wheat .... do....	159,120	11.7	13,600	1 50	238,680
Rye .... do....	36,000	12	3,000	96	34,560
Oats .... do....	1,225,000	35	35,000	48	588,000
Barley .... do....	102,900	21	4,900	78	80,262
Buckwheat .... do....	116,600	22	5,300	66	76,956
Potatoes .... do....	4,141,200	116	35,700	48	1,987,776
Hay .... tons..	630,600	1.03	612,233	9 43	5,946,558
Total	....	....	766,933	....	10,402,812
VERMONT.					
Indian corn .... bushels..	2,037,600	36	56,600	73	1,487,448
Wheat .... do....	494,000	15.2	32,500	1 39	686,660
Rye .... do....	55,200	12	4,600	79	43,608
Oats .... do....	3,818,100	33	115,700	40	1,527,240
Barley .... do....	132,600	26	5,100	81	107,406
Buckwheat .... do....	414,000	23	18,000	58	240,120
Potatoes .... do....	5,147,500	145	35,500	40	2,059,000
Hay .... tons..	1,271,000	1.11	1,145,045	8 16	10,371,360
Total	....	....	1,413,045	....	16,522,842
MASSACHUSETTS.					
Indian corn .... bushels..	1,386,000	36	38,500	78	1,081,080
Wheat .... do....	15,300	18	850	1 50	22,950
Rye .... do....	354,900	13	27,300	86	305,214
Oats .... do....	508,400	31	16,400	50	254,200
Barley .... do....	51,450	21	2,450	80	41,160
Buckwheat .... do....	40,800	12	3,400	66	26,928
Potatoes .... do....	4,243,200	104	40,800	56	2,376,192
Tobacco .... pounds..	4,350,000	1,500	2,900	11	478,500
Hay .... tons..	928,700	1.56	595,321	16 00	14,859,200
Total	....	....	727,921	....	19,445,424

Table showing the product of each principal crop, &c., for 1879—Continued.

Products.	Quantity produced in 1879.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
RHODE ISLAND.					
Indian corn……bushels..	268, 800	32	8, 400	$0 75	$201, 600
Rye……do....	22, 750	13	1, 750	85	19, 337
Oats……do....	72, 000	24	3, 000	44	31, 680
Barley……do....	8, 550	19	450	90	7, 695
Potatoes……do....	790, 000	100	7, 900	62	489, 800
Hay……tons..	113, 700	1. 58	71, 962	17 50	1, 989, 750
Total……	……	……	93, 462	……	2, 739, 862
CONNECTICUT.					
Indian corn……bushels..	2, 218, 500	29	76, 500	74	1, 641, 690
Wheat……do....	39, 600	18	2, 200	1 50	59, 400
Rye……do....	484, 800	16	30, 300	88	426, 624
Oats……do....	972, 900	23	42, 300	43	418, 347
Barley……do....	26, 400	22	1, 200	68	17, 952
Buckwheat……do....	117, 600	14	8, 400	76	89, 376
Potatoes……do....	3, 087, 000	98	31, 500	53	1, 636, 110
Tobacco……pounds..	9, 660, 000	1, 400	6, 900	12	1, 159, 200
Hay……tons..	927, 500	1. 40	662, 500	9 75	9, 043, 125
Total……	……	……	861, 800	……	14, 491, 824
NEW YORK.					
Indian corn……bushels..	22, 704, 000	33	688, 000	61	13, 849, 440
Wheat……do....	10, 746, 000	15	716, 400	1 40	15, 044, 400
Rye……do....	2, 770, 300	13	213, 100	75	2, 077, 725
Oats……do....	39, 928, 000	31	1, 288, 000	40	15, 971, 200
Barley……do....	6, 200, 000	25	248, 000	72	4, 464, 000
Buckwheat……do....	5, 152, 000	20	257, 600	54	2, 782, 080
Potatoes……do....	38, 407, 200	104	369, 300	36	13, 826, 592
Tobacco……pounds..	2, 432, 750	1, 315	1, 850	12	291, 930
Hay……tons..	6, 156, 000	1. 16	5, 306, 897	9 79	60, 267, 240
Total……	……	……	9, 089, 147	……	128, 574, 607
NEW JERSEY.					
Indian corn……bushels..	8, 969, 200	34	263, 800	58	5, 202, 136
Wheat……do....	1, 783, 500	12. 3	145, 000	1 38	2, 461, 230
Rye……do....	365, 750	9. 5	38, 500	79	288, 942
Oats……do....	5, 216, 000	32	163, 000	40	2, 086, 400
Buckwheat……do....	529, 200	28	18, 900	69	365, 148
Potatoes……do....	5, 170, 900	89	58, 100	59	3, 050, 831
Hay……tons..	661, 100	1. 25	528, 880	12 85	8, 495, 135
Total……	……	……	1, 216, 180	……	21, 949, 822
PENNSYLVANIA.					
Indian corn……bushels..	44, 506, 000	35	1, 271, 600	54	24, 033, 240
Wheat……do....	22, 307, 400	15. 3	1, 458, 000	1 32	29, 445, 768
Rye……do....	2, 973, 600	12	247, 800	68	2, 022, 048
Oats……do....	32, 531, 400	31	1, 049, 400	36	11, 711, 304
Barley……do....	618, 200	22	28, 100	83	513, 106
Buckwheat……do....	3, 740, 000	22	170, 000	60	2, 244, 000
Potatoes……do....	17, 513, 600	104	168, 400	37	6, 480, 032
Tobacco……pounds..	29, 617, 700	1, 459	20, 300	09	2, 665, 593
Hay……tons..	3, 409, 200	1. 34	2, 544, 179	12 88	43, 910, 496
Total……	……	……	6, 957, 779	……	123, 025, 587
DELAWARE.					
Indian corn……bushels..	4, 860, 000	27	180, 000	55	2, 673, 000
Wheat……do....	1, 012, 7[illegible]	13	77, 900	1 3[illegible]	1, 397, 526
Rye……do....	17, 000	17	1, 000	65	11, 050
Oats……do....	369, 600	22	16, 800	35	129, 360
Potatoes……do....	365, 200	83	4, 400	60	219, 120
Hay……tons..	34, 600	1. 08	32, 037	14 50	501, 700
Total……	……	……	312, 137	……	4, 931, 756

Table showing the product of each principal crop, &c., for 1879—Continued.

Products.	Quantity produced in 1879.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MARYLAND.					
Indian corn.....bushels..	13, 721, 040	30. 6	[illegible]	$0 52	$7, 134, 941
Wheat.....do....	6, 999, 819	14. 4	486, 100	1 42	9, 939, 773
Rye.....do....	243, 600	12	20, 300	80	194, 880
Oats.....do....	3, 638, 600	23	158, 200	40	1, 455, 440
Buckwheat.....do....	90, 000	20	4, 500	71	63, 900
Potatoes.....do....	1, 532, 200	94	16, 300	60	919, 320
Tobacco.....pounds..	25, 826, 400	633	40, 800	05	1, 291, 320
Hay.....tons..	203, 100	1. 20	169, 250	14 50	2, 944, 950
Totol.....	.....	.....	1, 343, 850	.....	23, 944, 524
VIRGINIA.					
Indian corn.....bushels..	19, 957, 600	19	1, 050, 400	$0 49	$9, 779, 224
Wheat.....do....	8, 851, 320	9. 2	962, 100	1 27	11, 241, 176
Rye.....do....	430, 200	9	47, 800	63	271, 026
Oats.....do....	5, 878, 800	12	489, 900	38	2, 233, 944
Buckwheat.....do....	52, 200	18	2, 900	62	32, 364
Potatoes.....do....	1, 255, 800	69	18, 200	56	703, 248
Tobacco.....pounds..	86, 524, 200	763	113, 400	05	4, 326, 210
Hay.....tons..	219, 900	1. 19	184, 790	12 40	2, 726, 760
Total.....	.....	.....	2, 869, 490	.....	31, 313, 952
NORTH CAROLINA.					
Indian corn.....bushels..	25, 678, 500	15	1, 711, 900	58	14, 893, 530
Wheat.....do....	3, 223, 500	7	460, 500	1 28	4, 126, 080
Rye.....do....	324, 800	8	40, 600	80	259, 840
Oats.....do....	4, 270, 400	16	266, 900	45	1, 921, 680
Potatoes.....do....	1, 104, 000	92	12, 000	63	695, 520
Tobacco.....pounds..	11, 898, 400	556	21, 400	07	832, 888
Hay.....tons..	118, 400	1. 39	85, 180	11 22	1, 328, 448
Cotton.....pounds..	97, 640, 400	156	625, 900	11	10, 740, 444
Total.....	.....	.....	3, 224, 380	.....	34, 798, 430
SOUTH CAROLINA.					
Indian corn.....bushels..	9, 702, 000	7. 5	1, 293, 600	75	7, 276, 500
Wheat.....do....	1, 140, 720	8. 4	135, 800	1 57	1, 790, 930
Rye.....do....	38, 000	5	7, 600	1 22	46, 360
Oats.....do....	1, 320, 000	15	88, 000	68	897, 600
Potatoes.....do....	103, 200	86	1, 200	98	101, 136
Hay.....tons..	25, 200	1. 25	20, 160	6 25	157, 500
Cotton.....pounds..	135, 077, 800	143	944, 600	11	14, 858, 558
Total.....	.....	.....	2, 490, 960	.....	25, 128, 584
GEORGIA.					
Indian corn.....bushels..	20, 627, 400	9. 3	2, 218, 000	70	14, 439, 180
Wheat.....do....	3, 617, 100	9	401, 900	1 26	4, 557, 546
Oats.....do....	6, 747, 000	15	449, 800	57	3, 845, 790
Potatoes.....do....	320, 000	64	5, 000	1 11	355, 200
Hay.....tons..	35, 000	1. 56	22, 436	14 59	510, 650
Cotton.....pounds..	248, 352, 000	156	1, 592, 000	10	24, 835, 200
Total.....	.....	.....	4, 689, 136	.....	48, 543, 566
FLORIDA.					
Indian corn.....bushels..	1, 945, 650	8. 5	228, 900	81	1, 575, 976
Oats.....do....	180, 800	16	11, 300	83	150, 064
Cotton.....pounds..	16, 968, 000	105	161, 600	10	1, 696, 800
Total.....	.....	.....	401, 800	.....	3, 422, 840
ALABAMA.					
Indian corn.....bushels..	25, 403, 300	13	1, 954, 100	66	16, 766, 178
Wheat.....do....	1, 502, 760	8. 4	178, 900	1 32	1, 983, 643
Oats.....do....	2, 675, 800	17	157, 400	65	1, 739, 270
Potatoes.....do....	450, 800	98	4, 600	1 00	450, 800
Hay.....tons..	34, 900	1. 57	22, 229	13 56	473, 244
Cotton.....pounds..	321, 750, 000	170	1, 892, 700	11	35, 393, 490
Total.....	.....	.....	4, 209, 929	.....	56, 806, 625

Table showing the product of each principal crop, &c., for 1879—Continued.

Products.	Quantity produced in 1879.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
MISSISSIPPI.					
Indian corn.....bushels..	24, 926, 400	16	1, 557, 900	$0 62	$15, 454, 368
Wheat.....do....	417, 600	7. 2	58, 000	1 36	567, 936
Oats.....do....	662, 360	11. 6	57, 100	61	404, 040
Potatoes.....do....	310, 000	79	4, 000	87	274, 920
Hay.....tons..	27, 200	1. 72	15, 814	14 83	403, 376
Cotton.....pounds..	[illegible]	[illegible]	[illegible]	10	[illegible]
Total.....	.....	.....	3, 747, 814	.....	55, 327, 610
LOUISIANA.					
Indian corn.....bushels..	12, 592, 500	15	839, 500	76	9, 570, 300
Oats.....do....	14, 000	14	1, 000	67	9, 380
Cotton.....pounds..	267, 044, 000	202	1, 322, 000	10	26, 704, 400
Sugar.....do....	211, 740, 000	1, 440	147, 059	07. 3	15, 457, 020
Total.....	.....	.....	2, 309, 559	.....	51, 741, 100
TEXAS.					
Indian corn.....bushels..	29, 198, 000	13	2, 246, 000	1 03	30, 073, 940
Wheat.....do....	3, 454, 200	7. 6	454, 500	1 15	3, 972, 330
Rye.....do....	32, 400	12	2, 700	1 00	32, 400
Oats.....do....	3, 962, 500	25	158, 500	62	2, 456, 750
Potatoes.....do....	310, 200	47	6, 600	1 29	400, 158
Hay.....tons..	131, 000	1. 08	121, 296	11 64	1, 524, 840
Cotton.....pounds..	338, 625, 000	175	1, 935, 000	10	33, 862, 500
Total.....	.....	.....	4, 924, 596	.....	72, 322, 918
ARKANSAS.					
Indian corn.....bushels..	22, 432, 800	24	934, 700	58	13, 011, 024
Wheat.....do....	1, 384, 000	8	173, 000	1 07	1, 480, 880
Rye.....do....	42, 900	11	3, 900	91	39, 039
Oats.....do....	1, 603, 120	23. 2	69, 100	46	737, 435
Potatoes.....do....	696, 600	86	8, 100	93	647, 838
Hay.....tons..	21, 800	1. 35	16, 148	14 10	307, 380
Cotton.....pounds..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total.....	.....	.....	2, 382, 448	.....	48, 604, 846
TENNESSEE.					
Indian corn.....bushels..	50, 897, 500	25	2, 035, 900	37	18, 832, 075
Wheat.....do....	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Rye.....do....	[illegible]	[illegible]	[illegible]	71	[illegible]
Oats.....do....	4, 986, 000	18	277, 000	35	1, 745, 100
Buckwheat.....do....	[illegible]	17	[illegible]	72	[illegible]
Potatoes.....do....	1, 925, 000	125	15, 400	52	1, 001, 000
Tobacco.....pounds..	44, 160, 000	800	55, 200	05	2, 208, 000
Hay.....tons..	164, 200	1. 19	137, 983	12 60	2, 068, 920
Cotton.....pounds..	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Total.....	.....	.....	4, 802, 283	.....	59, 501, 227
WEST VIRGINIA.					
Indian corn.....bushels..	11, 302, 600	31	364, 600	46	5, 199, 196
Wheat.....do....	[illegible]	13	[illegible]	[illegible]	[illegible]
Rye.....do....	247, 860	10. 2	24, 300	61	151, 195
Oats.....do....	2, 841, 020	22. 3	127, 400	32	909, 126
Barley.....do....	33, 000	10	3, 300	80	26, 400
Buckwheat.....do....	98, 700	21	4, 700	61	60, 207
Potatoes.....do....	992, 800	74	12, 200	46	415, 288
Tobacco.....pounds..	1, 875, 300	658	2, 850	06	112, 518
Hay.....tons..	[illegible]	[illegible]	[illegible]	11 26	[illegible]
Total.....	.....	.....	[illegible]	.....	[illegible]
KENTUCKY.					
Indian corn.....bushels..	64, 736, 000	32	2, 023, 000	37	23, 952, 320
Wheat.....do....	7, 681, 800	14	548, 700	1 08	8, 296, 344
Rye.....do....	[illegible]	13. 4	74, 800	73	731, 694
Oats.....do....	[illegible]	16. 8	279, 000	36	1, 687, 392
Barley.....do....	[illegible]	28	12, 100	81	274, 428
Potatoes.....do....	[illegible]	66	27, 500	51	925, 650
Tobacco.....pounds..	126, 880, 000	793	160, 000	05	6, 344, 000
Hay.....tons..	[illegible]	1. 18	222, 542	12 36	[illegible]
Total.....	.....	.....	3, 347, 642	.....	45, 457, 564

Table showing the product of each principal crop, &c., for 1879—Continued.

Products.	Quantity produced in 1879.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
OHIO.					
Indian corn.....bushels	105, 686, 000	35	3, 019, 600	$0 39	$41, 217, 540
Wheat.....do	36, 591, 750	19. 5	1, 876, 500	1 20	[illegible]
Rye.....do	1, 240, 160	18. 4	67, 400	69	[illegible]
Oats.....do	25, 716, 980	29. 9	860, 100	30	[illegible]
Barley.....do	1, 270, 500	33	38, 500	76	[illegible]
Buckwheat.....do	305, 900	19	16, 100	75	[illegible]
Potatoes.....do	10, 822, 800	87	124, 400	43	[illegible]
Tobacco.....pounds	14, 091, 000	671	21, 000	06	[illegible]
Hay.....tons	2, 456, 000	1. 17	2, 099, 145	10 65	[illegible]
Total.....	.....	.....	[illegible]	.....	[illegible]
MICHIGAN.					
Indian corn.....bushels	30, 913, 500	37	835, 500	45	[illegible]
Wheat.....do	28, 773, 120	19. 2	1, 498, 600	1 17	[illegible]
Rye.....do	218, 400	13	16, 800	64	[illegible]
Oats.....do	12, 686, 800	32. 2	394, 000	35	[illegible]
Barley.....do	1, 021, 800	26	39, 300	71	[illegible]
Buckwheat.....do	595, 200	16	37, 200	63	[illegible]
Potatoes.....do	10, 994, 900	113	97, 300	41	4, 507, 909
Hay.....tons	808, 800	1. 22	662, 951	12 56	10, 158, 528
Total.....	.....	.....	[illegible]	.....	67, 922, 672
INDIANA.					
Indian corn.....bushels	134, 920, 500	33	4, 088, 500	34	[illegible]
Wheat.....do	43, 709, 900	20. 3	2, 153, 200	1 17	[illegible]
Rye.....do	504, 000	17. 5	28, 800	71	[illegible]
Oats.....do	14, 028, 310	28. 3	495, 700	28	[illegible]
Barley.....do	550, 800	27	20, 400	76	[illegible]
Buckwheat.....do	160, 000	20	8, 000	70	[illegible]
Potatoes.....do	4, 080, 000	68	60, 000	41	[illegible]
Tobacco.....pounds	6, 636, 000	840	7, 900	05	[illegible]
Hay.....tons	1, 411, 200	1. 21	1, 166, 281	9 84	[illegible]
Total.....	.....	.....	8, 028, 781	.....	117, 731, 822
ILLINOIS.					
Indian corn.....bushels	312, 221, 000	35	8, 920, 600	31	96, 788, 510
Wheat.....do	44, 896, 830	18. 7	2, 400, 900	1 07	[illegible]
Rye.....do	4, 050, 000	18	225, 000	61	[illegible]
Oats.....do	47, 670, 400	32	1, 489, 700	27	[illegible]
Barley.....do	[illegible]	23	25, 000	59	[illegible]
Buckwheat.....do	[illegible]	17	8, 700	76	[illegible]
Potatoes.....do	12, 751, 200	88	144, 900	50	[illegible]
Tobacco.....pounds	4, 550, 000	650	7, 000	06	[illegible]
Hay.....tons	2, 648, 500	1. 21	2, 188, 843	9 39	[illegible]
Total.....	.....	.....	15, 410, 643	.....	192, 139, 295
WISCONSIN.					
Indian corn.....bushels	39, 912, 600	39	1, 023, 400	39	15, 565, 914
Wheat.....do	20, 565, 720	12. 6	1, 632, 200	1 04	21, 388, 349
Rye.....do	2, 808, 000	15	187, 200	63	1, 769, 040
Oats.....do	34, 663, 200	39	888, 800	30	10, 398, 960
Barley.....do	4, 320, 000	27	160, 000	61	2, 635, 200
Buckwheat.....do	520, 200	17	30, 600	70	364, 140
Potatoes.....do	13, 555, 800	102	132, 900	33	4, 473, 414
Tobacco.....pounds	5, 474, 900	1, 033	5, 300	12	656, 988
Hay.....tons	1, 227, 600	1. 44	852, 500	8 58	10, 532, 808
Total.....	.....	.....	4, 912, 900	.....	67, 784, 813
MINNESOTA.					
Indian corn.....bushels	15, 715, 000	35	449, 000	27	4, 243, 050
Wheat.....do	31, 886, 520	12. 3	2, 592, 400	94	29, 973, 329
Rye.....do	176, 000	22	8, 000	49	86, 240
Oats.....do	17, 136, 000	35	489, 600	23	3, 941, 280
Barley.....do	[illegible]	29	87, 900	43	1, 096, 113
Buckwheat.....do	[illegible]	20	6, 300	62	78, 120
Potatoes.....do	[illegible]	138	36, 600	25	1, 262, 700
Hay.....tons	[illegible]	1. 57	1, 025, 414	4 74	7, 630, 926
Total.....	.....	.....	4, 695, 214	.....	48, 311, 758

Table showing the product of each principal crop, &c., for 1879—Continued.

Products.	Quantity produced in 1879.	Average yield per acre.	Number of acres in each crop.	Value per bushel, pound, or ton.	Total valuation.
IOWA.					
Indian corn.....bushels..	185, 189, 200	38	4, 873, 400	$0 24	$44, 445, 408
Wheat.....do....	32, 786, 880	10. 2	3, 214, 400	92	30, 163, 930
Rye.....do....	365, 040	15. 6	23, 400	54	197, 122
Oats.....do....	37, 256, 400	36	1, 034, 900	23	8, 568, 972
Barley.....do....	4, 290, 000	22	195, 000	45	1, 930, 500
Buckwheat.....do....	144, 000	18	8, 000	69	99, 360
Potatoes.....do....	9, 090, 200	86	105, 700	32	2, 908, 864
Hay.....tons..	3, 564, 000	1. 54	2, 314, 286	4 54	16, 180, 560
Total.....	.....	.....	11, 769, 086	.....	104, 494, 716
MISSOURI.					
Indian corn.....bushels..	141, 939, 400	37	3, 836, 200	25	35, 484, 850
Wheat.....do....	26, 801, 600	14	1, 914, 400	1 01	27, 069, 616
Rye.....do....	804, 100	17	47, 300	61	490, 501
Oats.....do....	15, 429, 120	24. 6	627, 200	26	4, 011, 571
Buckwheat.....do....	56, 000	20	2, 800	63	35, 280
Potatoes.....do....	6, 897, 800	91	75, 800	48	3, 310, 944
Tobacco.....pounds..	15, 050, 100	663	22, 700	05	752, 505
Hay.....tons..	1, 053, 000	1. 06	993, 396	9 43	9, 929, 790
Total.....	.....	.....	7, 519, 796	.....	81, 085, 057
KANSAS.					
Indian corn.....bushels..	89, 720, 400	33	2, 718, 800	27	24, 224, 508
Wheat.....do....	18, 089, 500	11	1, 644, 500	89	16, 099, 655
Rye.....do....	2, 220, 000	20	111, 000	51	1, 132, 200
Oats.....do....	12, 015, 000	25	480, 600	26	3, 123, 900
Barley.....do....	675, 000	15	45, 000	43	290, 250
Buckwheat.....do....	69, 700	17	4, 100	91	63, 427
Potatoes.....do....	4, 184, 000	80	52, 300	79	3, 305, 360
Hay.....tons..	1, 499, 400	1. 67	897, 844	4 01	6, 012, 594
Total.....	.....	.....	5, 954, 144	.....	54, 251, 894
NEBRASKA.					
Indian corn.....bushels..	62, 459, 400	41	1, 523, 400	21	13, 116, 474
Wheat.....do....	13, 043, 590	11. 3	1, 154, 300	84	10, 956, 616
Rye.....do....	1, 192, 280	16. 4	72, 700	41	488, 835
Oats.....do....	6, 160, 000	32	192, 500	23	1, 416, 800
Barley.....do....	1, 600, 000	20	80, 000	37	592, 000
Buckwheat.....do....	47, 500	25	1, 900	68	32, 300
Potatoes.....do....	1, 215, 000	81	15, 000	36	437, 400
Hay.....tons..	620, 400	1. 83	339, 016	3 23	2, 003, 892
Total.....	.....	.....	3, 378, 816	.....	29, 044, 317
CALIFORNIA.					
Indian corn.....bushels..	2, 814, 000	28	100, 500	79	2, 223, 060
Wheat.....do....	35, 000, 000	14	2, 500, 000	1 23	43, 050, 000
Rye.....do....	230, 100	17. 7	13, 000	1 17	269, 217
Oats.....do....	5, 072, 100	32	153, 700	67	3, 398, 307
Barley.....do....	14, 501, 500	23	630, 500	56	8, 120, 840
Potatoes.....do....	4, 247, 900	107	39, 700	65	2, 761, 135
Hay.....tons..	1, 232, 900	1. 63	756, 380	9 93	12, 242, 697
Total.....	.....	.....	4, 193, 780	.....	72, 065, 256
OREGON.					
Indian corn.....bushels..	142, 400	32	4, 450	93	132, 432
Wheat.....do....	8, 188, 800	16	511, 800	98	8, 025, 024
Rye.....do....	24, 200	22	1, 100	1 00	24, 200
Oats.....do....	2, 916, 000	36	81, 000	44	1, 283, 040
Barley.....do....	480, 000	30	16, 000	64	307, 200
Potatoes.....do....	885, 600	123	7, 200	42	371, 952
Hay.....tons..	186, 200	2. 10	88, 667	10 80	2, 010, 960
Total.....	.....	.....	710, 217	.....	12, 154, 868
NEVADA, COLORADO, AND TERRITORIES.					
Indian corn.....bushels..	2, 751, 000	30	91, 700	90	2, 475, 900
Wheat.....do....	16, 900, 000	13	1, 300, 000	1 06	17, 914, 000
Oats.....do....	1, 815, 000	25	72, 600	66	1, 197, 900
Potatoes.....do....	1, 260, 000	120	10, 500	92	1, 159, 200
Tobacco.....pounds..	2, 251, 600	866	2, 600	7	157, 612
Hay.....tons..	320, 000	1. 28	250, 000	12 50	4, 000, 000
Cotton.....pounds..	31, 575, 000	250	126, 300	9. 5	2, 999, 625
Total.....	.....	.....	1, 853, 700	.....	29, 904, 237

Summary for each State, showing the product, the area, and the value of each crop for 1879.

STATES.	CORN.			WHEAT.			RYE.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Maine	1,587,000	52,900	$1,206,120	488,000	30,500	$702,720	46,800	2,600	$44,928
New Hampshire	1,859,000	57,200	1,450,020	159,120	13,600	238,680	36,000	3,000	34,560
Vermont	2,037,600	56,600	1,487,448	494,000	22,500	686,660	55,200	4,600	49,680
Massachusetts	1,386,000	38,500	1,081,080	15,300	850	22,950	354,900	27,300	305,214
Rhode Island	268,800	8,400	201,600	....	....	....	22,750	1,750	19,337
Connecticut	2,218,500	76,500	1,641,690	39,600	2,200	59,400	484,800	30,300	426,624
New York	22,704,000	688,000	13,849,440	10,746,000	716,400	15,044,400	2,770,300	213,100	2,077,725
New Jersey	8,969,200	263,800	5,202,136	1,783,500	115,000	2,461,230	365,750	38,500	288,942
Pennsylvania	44,506,000	1,271,600	21,033,240	22,307,400	1,458,000	29,445,768	2,973,600	247,800	2,022,048
Delaware	4,860,000	180,000	2,673,000	1,012,700	77,900	1,397,526	17,000	1,000	11,050
Maryland	13,721,040	448,400	7,134,941	6,999,840	486,100	9,939,773	243,600	20,300	194,880
Virginia	19,957,600	1,050,400	9,779,224	8,851,320	932,100	11,241,176	430,200	47,800	271,026
North Carolina	25,678,500	1,711,900	11,893,530	3,223,500	469,500	4,126,080	324,800	40,600	259,840
South Carolina	9,702,000	1,293,600	7,276,500	1,140,720	135,800	1,790,930	38,000	7,600	46,360
Georgia	20,627,400	2,218,000	14,439,180	3,617,100	401,900	4,557,546	....	....	....
Florida	1,945,650	228,900	1,575,976	....	....	....	....	....	....
Alabama	25,403,300	1,954,100	16,766,178	1,502,760	178,900	1,983,643	....	....	....
Mississippi	24,926,400	1,557,900	15,454,368	417,600	58,000	567,936	....	....	....
Louisiana	12,592,500	839,500	9,570,300	....	....	....	....	....	....
Texas	29,198,000	2,246,000	30,072,940	3,454,200	454,500	3,972,330	32,400	2,700	32,400
Arkansas	22,432,800	934,700	13,011,024	1,384,000	173,000	1,480,880	42,900	3,900	39,039
Tennessee	50,897,500	2,035,900	18,832,075	11,852,800	1,481,600	12,919,552	218,000	31,000	225,780
West Virginia	11,302,600	364,600	5,199,196	4,351,100	334,700	4,699,188	247,860	24,300	151,195
Kentucky	64,736,000	2,023,000	23,952,320	7,081,800	545,700	8,286,344	1,002,320	74,800	731,694
Ohio	105,686,000	3,019,600	41,217,540	36,591,750	1,876,500	43,910,100	1,220,160	67,400	855,710
Michigan	30,913,500	835,500	13,911,075	28,773,120	1,498,600	33,664,550	218,400	16,800	139,776
Indiana	134,920,500	4,088,500	45,872,970	43,769,900	2,153,200	51,149,663	504,000	28,000	357,840
Illinois	312,221,000	8,920,600	96,788,510	44,886,830	2,439,900	48,059,663	4,050,000	225,000	2,470,500
Wisconsin	29,912,600	1,023,400	15,735,914	20,565,720	1,632,200	21,388,349	2,808,000	187,200	1,769,040
Minnesota	15,715,000	449,000	4,243,050	31,856,570	2,592,400	29,973,399	176,000	8,000	86,240
Iowa	185,189,200	4,873,400	44,445,408	32,786,880	3,214,400	30,163,930	365,040	23,400	197,122
Missouri	141,939,400	3,836,200	35,484,850	26,881,600	1,914,400	27,069,616	804,100	47,300	490,501
Kansas	89,720,400	2,718,800	24,224,508	18,089,500	1,644,500	16,099,655	2,220,000	111,000	1,132,200
Nebraska	62,459,400	1,523,400	13,116,474	13,043,590	1,154,300	10,956,616	1,192,280	72,700	488,835
California	2,814,000	100,500	2,223,060	35,000,000	2,500,000	43,050,000	230,100	13,000	269,217
Oregon	142,400	4,450	132,432	8,188,800	511,800	8,025,024	24,200	1,100	24,200
Nevada, Colorado, and the Territories	2,751,000	91,700	2,475,900	16,900,000	1,300,000	17,914,000	....	....	....
Total	1,547,901,790	53,085,450	580,486,217	448,756,630	32,545,950	497,030,142	23,639,460	1,625,450	15,507,431

Summary for each State, showing the product, the area, and the value of each crop for 1879—Continued.

STATES.	OATS.			BARLEY.			BUCHWHEAT.		
	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.	Bushels.	Acres.	Value.
Maine	3, 087, 000	102, 900	$1, 327, 410	937, 500	37, 500	$750, 000	540, 000	18, 000	$318, 600
New Hampshire	1, 225, 000	35, 000	588, 000	102, 900	4, 900	80, 262	116, 600	5, 300	76, 956
Vermont	3, 818, 100	115, 700	1, 527, 240	132, 600	5, 100	107, 406	414, 000	18, 000	240, 120
Massachusetts	508, 400	16, 400	254, 200	51, 450	2, 450	41, 160	40, 800	3, 400	26, 928
Rhode Island	72, 000	3, 000	31, 680	8, 550	450	7, 695			
Connecticut	972, 900	42, 300	418, 347	26, 400	1, 200	17, 952	117, 600	8, 400	89, 376
New York	39, 928, 000	1, 288, 000	15, 971, 200	6, 200, 000	248, 000	4, 464, 000	5, 152, 000	257, 600	2, 782, 080
New Jersey	5, 216, 000	163, 000	2, 086, 400				529, 200	18, 900	365, 148
Pennsylvania	32, 531, 400	1, 049, 400	11, 711, 304	618, 200	28, 100	513, 106	3, 740, 000	170, 000	2, 244, 000
Delaware	369, 600	16, 800	129, 360						
Maryland	3, 638, 600	158, 200	1, 455, 440				90, 000	4, 500	63, 900
Virginia	5, 878, 800	489, 900	2, 233, 944				52, 200	2, 900	32, 364
North Carolina	4, 270, 400	266, 900	1, 921, 680						
South Carolina	1, 320, 000	88, 000	897, 600						
Georgia	6, 747, 000	449, 800	3, 845, 790						
Florida	180, 800	11, 300	150, 064						
Alabama	2, 675, 800	157, 400	1, 739, 270						
Mississippi	662, 360	57, 100	404, 040						
Louisiana	14, 000	1, 000	9, 380						
Texas	3, 962, 500	158, 500	2, 456, 750						
Arkansas	1, 603, 120	69, 100	737, 435						
Tennessee	4, 986, 000	277, 000	1, 745, 100				76, 500	4, 500	55, 080
West Virginia	2, 841, 020	127, 400	909, 126	33, 000	3, 300	26, 400	98, 700	4, 700	60, 207
Kentucky	4, 687, 200	279, 000	1, 687, 392	338, 800	12, 100	274, 428			
Ohio	25, 716, 990	860, 100	7, 715, 097	1, 270, 500	38, 500	965, 580	305, 900	16, 100	229, 425
Michigan	12, 686, 800	394, 000	4, 440, 380	1, 021, 800	39, 300	725, 478	595, 200	37, 200	374, 976
Indiana	14, 028, 310	495, 700	3, 927, 927	550, 800	20, 400	429, 624	160, 000	8, 000	112, 000
Illinois	47, 670, 400	1, 489, 700	12, 871, 008	575, 000	25, 000	339, 250	147, 900	8, 700	112, 404
Wisconsin	34, 663, 200	888, 800	10, 398, 960	4, 320, 000	160, 000	2, 635, 200	520, 200	30, 600	364, 140
Minnesota	17, 136, 000	489, 600	3, 941, 280	2, 549, 100	87, 900	1, 096, 113	126, 000	6, 300	78, 120
Iowa	37, 256, 400	1, 034, 900	8, 568, 972	4, 290, 000	195, 000	1, 930, 500	144, 000	8, 000	99, 360
Missouri	15, 429, 120	627, 200	4, 011, 571				56, 000	2, 800	35, 280
Kansas	12, 015, 000	480, 600	3, 123, 900	675, 000	45, 000	290, 250	69, 700	4, 100	63, 427
Nebraska	6, 160, 000	192, 500	1, 416, 800	1, 600, 000	80, 000	592, 000	47, 500	1, 900	32, 300
California	5, 072, 100	153, 700	3, 398, 307	14, 501, 500	630, 500	8, 120, 840			
Oregon	2, 916, 000	81, 000	1, 283, 040	480, 000	16, 000	307, 200			
Colorado, Nevada, and the Territories	1, 815, 000	72, 600	1, 197, 900						
Total	363, 761, 320	12, 683, 500	120, 533, 294	40, 283, 100	1, 680, 700	23, 714, 444	13, 140, 000	639, 900	7, 856, 191

Summary for each State showing the product, the area, and the value of each crop for 1879—Continued.

STATES.	POTATOES.			TOBACCO.			HAY.			COTTON.		
	Bushels.	Acres.	Value.	Pounds.	Acres.	Value.	Tons.	Acres.	Value.	Pounds.	Acres.	Value.
Maine	6, 993, 000	51, 800	$2, 937, 060				1, 247, 400	1, 091, 211	$11, 501, 028			
New Hampshire	4, 141, 200	35, 700	1, 987, 776				630, 600	612, 233	5, 946, 558			
Vermont	5, 147, 500	35, 500	2, 059, 000				1, 271, 900	1, 145, 045	10, 371, 360			
Massachusetts	4, 243, 200	40, 800	2, 376, 192	4, 350, 000	2, 900	$478, 500	928, 700	595, 321	14, 859, 200			
Rhode Island	790, 000	7, 900	489, 800				113, 700	71, 962	1, 989, 750			
Connecticut	3, 087, 000	31, 500	1, 636, 110	9, 660, 000	6, 900	1, 159, 200	927, 500	662, 500	9, 043, 125			
New York	38, 407, 200	369, 300	13, 826, 592	2, 432, 750	1, 850	291, 930	6, 156, 000	5, 306, 897	60, 267, 240			
New Jersey	5, 170, 900	58, 100	3, 050, 831				661, 100	528, 880	8, 495, 135			
Pennsylvania	17, 513, 600	168, 400	6, 480, 032	29, 617, 700	20, 300	2, 665, 593	3, 409, 200	2, 544, 179	43, 910, 496			
Delaware	365, 200	4, 400	219, 120				34, 600	32, 037	501, 700			
Maryland	1, 532, 200	16, 300	919, 320	25, 826, 400	40, 800	1, 291, 320	203, 100	169, 250	2, 944, 950			
Virginia	1, 255, 800	18, 200	703, 248	86, 524, 200	113, 400	4, 326, 210	219, 900	184, 790	2, 726, 760			
North Carolina	1, 104, 000	12, 000	695, 520	11, 898, 400	21, 400	832, 888	118, 400	85, 180	1, 328, 448	97, 640, 400	625, 900	$10, 740, 444
South Carolina	103, 200	1, 200	101, 136				25, 200	20, 160	157, 500	135, 677, 800	944, 600	14, 858, 558
Georgia	320, 000	5, 000	355, 200				35, 000	22, 436	510, 650	248, 252, 000	1, 592, 000	24, 835, 200
Florida										16, 968, 000	161, 600	1, 696, 800
Alabama	450, 800	4, 600	450, 800				34, 900	22, 229	473, 244	321, 759, 000	1, 892, 700	35, 393, 490
Mississippi	316, 000	4, 000	274, 920				27, 200	15, 814	403, 376	382, 230, 000	2, 055, 000	38, 223, 000
Louisiana										267, 044, 000	1, 322, 000	26, 704, 400
Texas	310, 200	6, 600	400, 158				131, 000	121, 296	1, 524, 840	338, 625, 000	1, 935, 000	33, 862, 500
Arkansas	696, 600	8, 100	647, 838				21, 800	16, 148	307, 380	323, 812, 500	1, 177, 500	32, 381, 250
Tennessee	1, 925, 000	15, 400	1, 001, 000	44, 160, 000	55, 200	2, 208, 000	164, 200	137, 983	2, 068, 920	204, 457, 200	762, 900	20, 445, 720
West Virginia	902, 800	12, 200	415, 288	1, 875, 300	2, 850	112, 518	232, 000	239, 175	2, 612, 329			
Kentucky	1, 815, 000	27, 500	925, 650	126, 880, 000	160, 000	6, 344, 000	262, 600	222, 542	3, 245, 736			
Ohio	10, 822, 800	124, 400	4, 653, 804	14, 091, 000	21, 000	845, 460	2, 456, 000	2, 099, 145	26, 156, 400			
Michigan	10, 994, 900	97, 300	4, 507, 909				808, 800	662, 951	10, 158, 528			
Indiana	4, 080, 000	60, 000	1, 672, 800	6, 636, 000	7, 900	331, 800	1, 411, 200	1, 166, 281	13, 886, 208			
Illinois	12, 751, 200	144, 900	6, 375, 600	4, 550, 000	7, 000	273, 000	2, 648, 500	2, 188, 843	24, 869, 415			
Wisconsin	13, 555, 800	132, 900	4, 473, 414	5, 474, 900	5, 300	656, 988	1, 227, 600	852, 500	10, 532, 808			
Minnesota	5, 050, 800	36, 600	1, 262, 700				1, 609, 900	1, 025, 414	7, 639, 926			
Iowa	9, 090, 200	105, 700	2, 908, 864				3, 564, 000	2, 314, 286	16, 180, 560			
Missouri	6, 897, 800	75, 800	3, 310, 944	15, 050, 100	22, 700	752, 505	1, 053, 000	993, 396	9, 929, 790			
Kansas	4, 184, 000	52, 300	3, 305, 360				1, 499, 400	897, 844	6, 012, 594			
Nebraska	1, 215, 000	15, 000	437, 400				620, 400	339, 016	2, 003, 892			
California	4, 247, 900	39, 700	2, 761, 135				1, 232, 900	756, 380	12, 242, 697			
Oregon	885, 600	7, 200	371, 952				186, 200	88, 667	2, 010, 960			
Colorado, Nevada, and the Territories	1, 260, 000	10, 500	1, 159, 200	*2, 251, 600	2, 600	157, 612	320, 000	250, 000	4, 000, 000	†31, 575, 000	126, 300	2, 999, 625
Total	181, 626, 400	1, 836, 800	79, 153, 673	391, 278, 350	492, 100	22, 727, 524	35, 493, 000	27, 484, 991	330, 804, 494	‡2, 367, 540, 900	12, 595, 500	242, 140, 987

* This amount includes an aggregate estimate of the tobacco crop of States left blank in the column above.

† Produced chiefly in Indian Territory.

‡ 5,261,202 bales of 450 pounds each.

Table showing the average yield per acre and the price per bushel, pound, or ton of farm products for the year 1879.

States.	Corn.		Wheat.		Rye.		Oats.		Barley.		Buckwheat.		Potatoes.		Tobacco.		Hay.		Cotton.	
	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Bushels.	Price per bushel.	Pounds.	Price per pound.	Tons.	Price per ton.	Pounds.	Price per pound.
Maine	30.0	$0 76	16.0	$1 44	18.0	$0 96	30.0	$0 43	25.0	$0 80	30.0	$0 59	125	$0 42	......	......	1.14	$9 22	......	......
New Hampshire	32.5	78	11.7	1 50	12.0	96	35.0	48	21.0	76	22.0	66	116	48	......	......	1.03	9 43	......	......
Vermont	36.0	73	15.2	1 39	12.0	79	33.0	40	26.0	81	23.0	58	115	40	......	......	1.11	8 16	......	......
Massachusetts	36.0	76	18.0	1 50	13.0	86	31.0	50	21.0	80	12.0	66	144	56	1,500	$0 11	1.56	16 00	......	......
Rhode Island	32.0	75	......	......	13.0	85	24.0	44	19.0	90	......	......	140	62	......	......	1.55	17 50	......	......
Connecticut	29.0	74	18.0	1 50	16.0	88	23.0	43	22.0	68	14.0	76	93	56	1,400	12	1.40	9 75	......	......
New York	33.0	61	15.0	1 40	13.0	75	31.0	40	25.0	72	20.0	54	137	56	1,315	12	1.16	9 79	......	......
New Jersey	34.0	56	12.3	1 38	9.5	79	32.0	40	......	......	27.0	69	80	59	......	......	1.25	12 85	......	......
Pennsylvania	35.0	54	15.3	1 32	12.0	68	31.0	36	22.0	83	22.0	60	104	37	1,459	9	1.34	12 88	......	......
Delaware	27.0	55	13.0	1 38	17.0	65	22.0	35	......	......	......	......	83	60	......	......	1.08	14 50	......	......
Maryland	30.6	52	14.4	1 42	12.0	80	23.0	40	......	......	20.0	71	91	60	623	5	1.20	14 50	......	......
Virginia	19.0	49	9.2	1 27	9.0	63	12.0	38	......	......	18.0	62	60	56	763	5	1.19	12 49	......	......
North Carolina	15.0	55	7.0	1 23	8.0	89	16.0	45	......	......	......	......	92	63	556	7	1.39	11 22	156	$0 11
South Carolina	7.5	75	8.4	1 57	5.0	1 22	15.0	68	......	......	......	......	86	98	......	......	1.25	6 25	142	11
Georgia	9.3	70	9.0	1 26	......	......	15.0	57	......	......	......	......	64	1 11	......	......	1.56	14 50	156	10
Florida	8.5	81	......	......	......	......	16.0	83	......	......	......	......	......	......	......	......	......	......	105	10
Alabama	13.0	66	8.4	1 32	......	......	17.0	65	......	......	......	......	93	1 09	......	......	1.57	13 56	170	11
Mississippi	16.0	62	7.2	1 36	......	......	11.6	61	......	......	......	......	79	87	......	......	1.72	14 85	185	10
Louisiana	15.0	76	......	......	......	......	14.0	67	......	......	......	......	......	......	......	......	......	......	292	10
Texas	13.0	1 63	7.6	1 15	12.0	1 00	25.0	62	......	......	......	......	47	1 20	......	......	1.08	11 64	175	10
Arkansas	24.0	55	8.0	1 67	11.0	91	23.2	46	......	......	......	......	76	93	......	......	1.35	14 10	275	10
Tennessee	25.0	37	8.0	1 09	10.0	71	18.0	35	......	......	17.0	72	125	52	800	5	1.19	12 60	263	10
West Virginia	31.0	46	13.0	1 03	10.2	61	22.3	32	10.0	80	21.0	61	71	46	658	6	97	11 26	......	......
Kentucky	32.0	57	14.0	1 08	13.4	73	16.8	36	28.0	81	......	......	66	51	793	5	1.18	12 36	......	......
Ohio	35.0	39	19.5	1 20	18.4	69	29.9	30	32.0	76	19.0	75	87	43	671	6	1.17	10 65	......	......
Michigan	37.0	45	19.2	1 17	13.0	64	32.2	35	26.0	71	16.0	63	118	41	......	......	1.22	12 56	......	......
Indiana	33.0	24	20.3	1 17	17.5	71	28.3	28	27.0	78	20.0	70	65	41	840	5	1.21	9 84	......	......
Illinois	35.0	31	18.7	1 07	18.0	61	32.0	27	23.0	59	17.0	76	88	50	650	6	1.21	9 39	......	......
Wisconsin	39.0	30	12.6	1 04	15.0	63	39.0	30	27.0	61	17.0	70	102	33	1,033	12	1.44	8 58	......	......
Minnesota	35.0	27	12.3	94	22.0	49	35.0	23	29.0	43	20.0	62	128	25	......	......	1.57	4 74	......	......
Iowa	38.0	24	10.2	92	15.6	54	36.0	23	22.0	45	18.0	69	86	32	......	......	1.54	4 54	......	......
Missouri	37.0	25	14.0	1 01	17.0	61	24.6	26	......	......	20.0	63	91	48	663	5	1.03	9 43	......	......
Kansas	33.0	27	11.0	89	20.0	51	25.0	26	15.0	43	17.0	91	80	79	......	......	1.67	4 01	......	......
Nebraska	41.0	21	11.3	84	16.4	41	32.0	23	20.0	37	25.0	68	81	36	......	......	1.83	3 23	......	......
California	28.0	79	14.0	1 23	17.7	1 17	33.0	67	23.0	56	......	......	107	65	......	......	1.63	9 93	......	......
Oregon	32.0	93	16.0	98	22.0	1 00	36.0	44	30.0	64	......	......	123	42	......	......	2.10	10 80	......	......
Nevada, Colorado, and the Territories	30.0	90	13.0	1 06	......	......	25.0	66	......	......	......	......	120	92	866	7	1.28	12 50	250	09.5

Table showing the average cash value per acre of farm products for the year 1879.

States.	Corn.	Wheat.	Rye.	Oats.	Barley.	Buckwheat.	Potatoes.	Tobacco.	Hay.	Cotton.
Maine	$22 80	$23 04	$17 28	$12 90	$20 00	$17 70	$56 70	....	$10 51	......
New Hampshire	25 85	17 55	11 52	16 80	16 38	14 52	55 68	....	9 71	......
Vermont	26 28	21 13	9 48	13 20	21 06	13 34	58 00	....	9 06	......
Massachusetts	23 08	27 00	11 18	15 50	16 80	7 92	58 24	$165 00	24 96	......
Rhode Island	24 00	....	11 05	10 56	17 10	....	62 00	....	27 65	......
Connecticut	21 46	27 00	14 08	9 89	14 96	10 64	51 94	168 00	13 65	......
New York	20 13	21 00	9 75	12 40	18 00	10 80	37 44	157 80	11 36	......
New Jersey	19 72	16 97	7 50	12 80	....	19 32	52 51	....	16 06	......
Pennsylvania	18 90	20 20	8 16	11 16	18 26	13 20	38 48	131 31	17 26	......
Delaware	14 85	17 94	11 05	7 70	....	....	49 80	....	15 66	......
Maryland	15 91	20 45	9 60	9 20	....	14 20	56 40	31 65	17 40	......
Virginia	9 31	11 68	5 67	4 56	....	11 16	38 64	38 15	14 76	......
North Carolina	8 70	8 96	6 40	7 20	....	....	57 96	38 92	15 60	$17 16
South Carolina	5 62	13 19	6 10	10 20	....	....	84 28	....	7 81	15 73
Georgia	6 51	11 34	....	8 55	....	....	71 04	....	22 76	15 69
Florida	6 83	....	....	13 26	....	....	....	....	....	10 50
Alabama	8 58	11 09	....	11 05	....	....	98 00	....	21 29	18 70
Mississippi	9 92	9 79	....	7 08	....	....	68 73	....	25 51	18 60
Louisiana	11 40	....	....	9 38	....	....	....	....	....	20 20
Texas	13 39	8 74	12 00	15 50	....	....	60 63	....	12 57	17 50
Arkansas	13 92	8 56	10 01	10 67	....	....	79 98	....	19 03	27 50
Tennessee	9 25	8 72	7 10	6 30	....	12 24	65 00	40 00	14 99	26 80
West Virginia	14 26	14 04	6 22	7 14	8 00	12 81	34 04	39 48	10 92	......
Kentucky	11 84	15 12	9 78	6 05	22 68	....	33 66	39 65	14 58	......
Ohio	13 65	23 40	12 70	8 97	25 08	14 25	37 41	40 26	12 46	......
Michigan	16 65	22 46	8 32	11 27	18 46	10 08	46 33	....	15 32	......
Indiana	11 22	23 75	12 42	7 92	21 06	14 00	27 88	42 00	11 91	......
Illinois	10 85	20 01	10 98	8 64	13 57	12 62	44 00	39 00	11 36	......
Wisconsin	15 21	13 10	9 45	11 70	16 47	11 90	33 66	123 96	12 36	......
Minnesota	9 45	11 56	10 78	8 05	12 47	12 40	34 50	....	7 44	......
Iowa	9 12	9 38	8 42	8 28	9 00	12 42	27 52	....	6 99	......
Missouri	9 25	14 14	10 37	6 40	....	12 60	43 68	33 15	10 00	......
Kansas	8 91	9 79	10 20	6 50	6 45	15 47	63 20	....	6 70	......
Nebraska	8 61	9 49	6 72	7 36	7 40	17 00	29 16	....	5 91	......
California	22 12	17 22	20 71	22 11	12 88	....	69 55	....	16 19	......
Oregon	29 76	15 63	22 00	15 84	19 20	....	51 66	....	22 68	......
Nevada, Colorado, and the Territories.	27 00	13 78	....	16 50	....	....	110 40	60 62	16 00	23 75

Table showing the average cash value per acre of the principal crops of the farm, taken together, for the year 1879.

States.	Average value per acre.	States.	Average value per acre.
Maine	$13 51	Texas	$14 69
New Hampshire	13 56	Arkansas	20 40
Vermont	11 69	Tennessee	12 39
Massachusetts	26 71	West Virginia	12 74
Rhode Island	29 32	Kentucky	13 58
Connecticut	16 82	Ohio	15 58
New York	14 15	Michigan	18 96
New Jersey	18 05	Indiana	14 66
Pennsylvania	17 68	Illinois	12 47
Delaware	15 80	Wisconsin	13 80
Maryland	17 82	Minnesota	10 29
Virginia	10 91	Iowa	8 88
North Carolina	10 79	Missouri	10 78
South Carolina	10 09	Kansas	9 11
Georgia	10 35	Nebraska	8 60
Florida	8 52	California	17 18
Alabama	13 49	Oregon	17 11
Mississippi	14 76	Nevada, Colorado, and the Territories	16 13
Louisiana	22 40		

A general summary showing the estimated quantities, number of acres, and aggregate value of the principal crops of the farm in 1879.

Products.	Number of bushels, &c.	Number of acres.	Value.
Indian corn ....bushels..	1,547,901,790	53,085,450	$580,486,217
Wheat ....do....	448,756,630	32,545,950	497,030,142
Rye ....do....	23,639,460	1,625,450	15,507,431
Oats ....do....	363,761,320	12,683,500	120,533,294
Barley ....do....	40,283,100	1,680,700	23,714,444
Buckwheat ....do....	13,140,000	639,900	7,856,191
Potatoes ....do....	181,626,400	1,836,800	79,153,673
Total........	2,619,108,700	104,097,750	1,324,281,392
Tobacco ....pounds..	391,278,350	492,100	22,727,524
Hay........tons..	35,493,000	27,484,991	330,804,494
Cotton ....bales..	5,261,202	12,595,500	242,140,987
Grand total........	....	144,670,341	1,919,954,397

Table showing the average yield and cash value per acre, and price per bushel, pound, or ton, of farm products for the year 1879.

Products.	Average yield per acre.	Average price per bushel.	Average value per acre.	Products.	Average yield per acre.	Average price per bushel, pound, or ton.	Average value per acre.
Indian corn ....bushels..	29.2—	$0 37.5+	$10 93	Buckwheat ...bushels..	20.5 +	$0 59.8—	$12 28
Wheat ....do....	13.8—	1 10.8—	15 27	Potatoes ....do....	98.9 —	43.6—	43 09
Rye ....do....	14.5+	65.6—	9 54	Tobacco ....pounds..	795.1 +	5.8+	46 18
Oats ....do....	28.7—	33.1+	9 50	Hay ....tons..	1.29+	9 32.0+	12 04
Barley........do....	24.0—	58.9—	14 11	Cotton........pounds..	188.0 —	10.2+	19 22

CONDITION OF FARM ANIMALS.

The condition of farm animals for the year 1879 has been very favorable; although the winter was one of unusual severity, there were no diseases other than local influenzas reported. More care seems to be given to the proper housing and feeding during the severe weather of winter than was formerly done. During the summer and fall many counties reported absolutely no disease among stock; a few cases of supposed pleuro-pneumonia were reported in New Jersey and Maryland among cattle, and the usual report of swine disease was made in all the large corn-producing States. The estimate of numbers of farm animals shows no material change in the number of cattle; an increase of 2 per cent. in horses, and 6 per cent in sheep, while swine show a decrease of nearly three per cent.

The price, however, shows a decided advance in all live stock since a year ago.

The average per capita for the whole country, and for all ages, during the last four years is as follows:

	January, 1877.	January, 1878.	January, 1879.	January, 1880.
Horses........	$60 08	$58 16	$52 41	$54 75
Mules	68 91	63 70	56 06	61 26
Milch cows	27 32	26 41	21 73	23 27
Oxen and other cattle........	17 10	17 14	15 39	16 10
Sheep........	2 27	2 25	2 07	2 21
Swine........	6 09	4 98	3 18	4 28

Table showing the estimated total number and total value of each kind of live stock, and the average price, in January, 1880.

STATES.	HORSES.			MULES.			MILCH COWS.		
	Number.	Average price.	Value.	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	81, 700	$60 15	$4, 914, 255	....	....	....	160, 600	$24 10	$3, 870, 460
New Hampshire	57, 100	61 40	3, 505, 940	....	....	....	98, 100	28 00	2, 746, 800
Vermont	77, 400	63 55	4, 918, 770	....	....	....	207, 100	25 05	5, 187, 855
Massachusetts	136, 200	95 52	13, 009, 824	....	....	....	167, 100	35 00	5, 848, 500
Rhode Island	16, 200	94 50	1, 530, 900	....	....	....	22, 000	30 00	660, 000
Connecticut	54, 000	59 20	3, 196, 800	....	....	....	118, 800	29 37	3, 489, 156
New York	898, 900	76 41	68, 684, 949	11, 800	$91 84	$1, 083, 712	1, 431, 700	29 06	41, 605, 202
New Jersey	114, 500	79 76	9, 132, 520	13, 700	106 93	1, 464, 941	153, 700	35 10	5, 394, 870
Pennsylvania	602, 200	67 22	40, 479, 884	24, 700	86 07	2, 125, 929	836, 700	26 66	22, 306, 422
Delaware	20, 300	74 25	1, 507, 275	4, 000	89 58	358, 320	24, 800	32 50	806, 000
Maryland	108, 600	62 30	6, 765, 780	11, 300	81 29	918, 577	99, 500	27 20	2, 706, 400
Virginia	212, 900	56 72	12, 075, 688	30, 300	67 41	2, 042, 523	240, 600	18 86	4, 537, 716
North Carolina	146, 700	59 22	8, 687, 574	74, 700	61 65	4, 605, 255	230, 000	12 60	2, 898, 000
South Carolina	62, 000	79 69	4, 940, 780	53, 000	90 78	4, 811, 340	132, 600	15 25	2, 022, 150
Georgia	119, 200	67 60	8, 057, 920	98, 200	76 58	7, 520, 156	273, 100	13 26	3, 621, 306
Florida	22, 400	59 00	1, 321, 600	11, 900	62 94	748, 986	72, 800	9 27	674, 856
Alabama	113, 900	56 63	6, 450, 157	115, 100	64 21	7, 390, 571	217, 300	13 50	2, 933, 550
Mississippi	99, 100	57 73	5, 721, 043	104, 000	70 89	7, 372, 560	190, 700	13 06	2, 490, 542
Louisiana	82, 500	38 15	3, 147, 375	80, 700	69 56	5, 613, 492	115, 200	18 00	2, 073, 600
Texas	963, 900	22 13	21, 331, 107	191, 000	41 84	7, 991, 440	566, 300	13 85	7, 843, 255
Arkansas	191, 100	45 28	8, 653, 008	92, 900	55 86	5, 189, 394	199, 000	13 66	2, 718, 340
Tennessee	326, 900	49 75	16, 263, 275	96, 700	55 91	5, 406, 497	248, 100	17 09	4, 240, 029
West Virginia	124, 600	47 86	5, 963, 356	2, 500	51 56	128, 900	131, 800	20 97	2, 763, 846
Kentucky	402, 400	45 04	18, 124, 096	109, 600	48 54	5, 319, 984	270, 000	22 62	6, 107, 400
Ohio	811, 300	57 53	46, 674, 089	24, 800	60 69	1, 505, 112	700, 000	26 44	18, 508, 000
Michigan	350, 500	75 68	26, 525, 840	4, 400	85 12	374, 528	416, 900	26 68	11, 122, 892
Indiana	688, 800	54 60	37, 608, 480	58, 800	60 72	3, 570, 336	434, 800	25 09	10, 909, 132
Illinois	1, 078, 000	51 66	55, 689, 480	133, 900	60 64	8, 119, 696	695, 400	26 63	18, 518, 502
Wisconsin	392, 100	60 24	23, 620, 104	8, 900	72 89	648, 721	458, 200	21 79	9, 984, 178
Minnesota	274, 500	64 58	17, 727, 210	7, 300	88 81	648, 313	304, 000	20 16	6, 128, 640
Iowa	778, 400	55 19	42, 959, 896	44, 700	70 85	3, 166, 995	724, 500	24 20	17, 532, 900
Missouri	639, 800	40 37	25, 828, 726	191, 900	47 53	9, 121, 007	526, 500	19 21	10, 114, 065
Kansas	299, 700	48 62	14, 571, 414	57, 000	63 02	3, 592, 140	351, 400	23 68	8, 321, 152
Nebraska	176, 100	64 34	11, 330, 274	15, 200	87 29	1, 326, 808	142, 900	26 00	3, 715, 400
California	273, 000	46 18	12, 607, 140	25, 700	67 54	1, 735, 778	473, 400	28 65	13, 562, 910
Oregon	117, 400	51 93	6, 096, 582	3, 600	46 33	166, 788	121, 400	17 71	2, 149, 994
Nevada, Colorado, and the Territories	287, 500	47 56	13, 673, 500	27, 200	69 10	1, 879, 520	470, 000	20 82	9, 785, 400
Total	11, 201, 800	....	613, 296, 611	1, 729, 500	....	105, 948, 319	12, 027, 000	....	279, 899, 420
Grand average of prices	....	54, 75	....	....	61 26	....	....	23 27	....

Table showing the estimated total number and total value of each kind of live stock, &c.—Continued.

STATES.	OXEN AND OTHER CATTLE.			SHEEP.			HOGS.		
	Number.	Average price.	Value.	Number.	Average price.	Value.	Number.	Average price.	Value.
Maine	203, 700	$24 00	$4, 888, 800	596, 300	$3 23	$1, 926, 049	60, 000	$7 93	$475, 800
New Hampshire	122, 500	29 36	3, 596, 690	242, 100	2 83	685, 143	45, 000	11 75	528, 750
Vermont	126, 500	21 03	2, 660, 295	498, 600	3 48	1, 735, 128	49, 400	7 61	375, 934
Massachusetts	114, 900	34 14	3, 922, 686	63, 300	3 58	226, 614	84, 900	12 46	1, 057, 854
Rhode Island	15, 700	30 05	471, 785	28, 200	3 70	104, 340	13, 800	8 70	120, 060
Connecticut	125, 600	28 95	3, 636, 120	97, 100	3 40	330, 140	60, 600	8 84	535, 704
New York	668, 600	26 22	17, 530, 692	2, 205, 800	3 57	7, 874, 706	936, 000	7 16	6, 701, 760
New Jersey	84, 500	29 77	2, 515, 565	127, 400	4 01	510, 874	152, 900	7 40	1, 131, 460
Pennsylvania	659, 500	21 69	14, 304, 555	1, 649, 300	3 01	4, 964, 393	909, 200	6 88	6, 255, 296
Delaware	32, 000	30 67	981, 440	38, 800	3 83	148, 604	47, 600	5 63	267, 988
Maryland	120, 400	19 74	2, 376, 696	152, 700	3 13	477, 951	264, 800	4 99	1, 321, 352
Virginia	431, 100	15 51	6, 686, 361	426, 100	2 23	950, 203	692, 100	3 50	2, 422, 350
North Carolina	415, 800	8 31	3, 455, 298	425, 000	1 45	616, 250	1, 262, 600	3 15	3, 977, 190
South Carolina	191, 800	10 52	2, 017, 736	176, 500	1 76	310, 640	544, 000	2 81	1, 528, 640
Georgia	400, 800	7 93	3, 178, 344	374, 400	1 44	539, 136	1, 684, 800	3 14	5, 290, 272
Florida	518, 900	6 08	3, 154, 912	59, 900	1 75	104, 825	217, 300	2 33	506, 309
Alabama	267, 800	7 75	2, 075, 450	214, 200	1 55	332, 010	1, 117, 000	2 78	3, 105, 260
Mississippi	247, 500	7 69	1, 903, 275	200, 300	1 52	304, 456	1, 636, 300	2 70	4, 418, 010
Louisiana	119, 900	9 60	1, 151, 040	135, 100	1 67	225, 617	378, 500	4 02	1, 521, 570
Texas	4, 464, 000	8 88	39, 640, 320	5, 148, 400	1 89	9, 730, 476	1, 817, 800	2 55	4, 635, 390
Arkansas	371, 300	10 48	3, 891, 224	293, 500	1 56	457, 860	1, 146, 000	2 97	3, 403, 620
Tennessee	397, 400	10 91	4, 347, 556	858, 500	1 60	1, 373, 600	1, 710, 000	3 43	5, 865, 300
West Virginia	232, 700	18 76	4, 365, 452	600, 500	2 11	1, 285, 070	287, 100	3 69	1, 033, 560
Kentucky	460, 700	19 05	8, 776, 335	1, 009, 800	2 53	2, 554, 794	1, 812, 000	3 26	5, 907, 120
Ohio	792, 000	22 37	17, 717, 040	4, 080, 400	2 83	11, 547, 532	2, 045, 200	5 01	10, 246, 452
Michigan	432, 600	22 51	9, 737, 826	1, 856, 400	2 53	4, 696, 692	538, 800	4 92	2, 650, 896
Indiana	756, 600	18 65	14, 110, 590	1, 019, 000	2 29	2, 333, 510	2, 186, 000	4 70	10, 274, 200
Illinois	1, 235, 300	21 09	26, 052, 477	1, 110, 800	2 60	2, 888, 080	3, 202, 600	5 61	17, 966, 586
Wisconsin	522, 700	17 83	9, 319, 741	1, 316, 100	2 39	3, 145, 479	571, 800	5 07	2, 899, 026
Minnesota	322, 400	17 46	5, 629, 104	307, 500	2 13	654, 975	194, 200	5 28	1, 025, 376
Iowa	1, 370, 400	19 44	26, 640, 576	454, 400	2 54	1, 154, 176	2, 778, 400	5 36	14, 892, 224
Missouri	1, 648, 300	17 47	28, 795, 801	1, 523, 300	1 83	2, 787, 639	2, 620, 400	3 44	9, 014, 176
Kansas	647, 700	20 32	13, 161, 264	371, 900	2 23	829, 337	1, 208, 700	5 28	6, 381, 936
Nebraska	428, 000	21 52	9, 210, 560	172, 800	2 73	471, 744	698, 700	5 21	3, 640, 227
California	999, 900	18 47	18, 468, 153	7, 646, 800	1 62	12, 387, 816	661, 000	3 97	2, 624, 170
Oregon	201, 500	11 39	2, 295, 085	1, 265, 100	1 46	1, 847, 046	228, 500	2 60	594, 100
Nevada, Colorado, and the Territories	1, 080, 000	17 68	19, 094, 400	4, 019, 600	1 92	7, 717, 632	170, 100	6 97	1, 185, 597
Total	21, 231, 000	....	341, 761, 154	40, 765, 900	....	90, 230, 537	34, 034, 100	....	145, 781, 515
Grand average of prices	....	16 10	....	....	2 21	....	....	4 28	....

HOPS.

The hop crop reached its greatest production in 1877, in which year it is estimated that 60,000 acres were planted, yielding an average of 650 pounds per acre, and resulting in a total crop of 39,000,000 pounds. The exports for the fiscal year ending June 30, 1878, and which were of the crop of 1877, were 18,458,782 pounds. The low prices consequent on such large production, added to a crop of very poor quality, made the crop gathered in 1878 a very disastrous industry for those engaged in it, and caused a large area in hops to be abandoned. For 1879 it was estimated that a decrease of 20 per cent. had taken place in the area cultivated, leaving 48,000 acres in hops. New York and Wisconsin grew over two-thirds of the crop of the country. Owing to disaster in the crop in Europe the price has advanced to 30 cents per pound against 10 cents last year, and the export which, for the fiscal year ending June 30, 1879, only amounted to 5,458,159 pounds, has risen in the six months succeeding that date to 9,370,377 pounds.

PEANUTS (*Arachis hypogæa*).

This nut, sometimes called pindar and ground-nut, is a native of Africa. It was first grown in this country in North and South Carolina and exported to France. Afterward, and until the last twenty years, it was imported into this country for the manufacture of oil. Of late years the importation has fallen very low, owing to the increase of cultivation keeping pace with the demand. It is still used for the manufacture of oil, and largely used in adulterating chocolate, but the great demand is for edible purposes.

The crop shows a great increase since 10 years.

The States of Virginia, Tennessee, and North Carolina grow five-sixths of the crop, but it is cultivated to a small extent for home use in all the Southern States. In 1875 the total crop was 785,000 bushels, being 115,000 more than the year previous; in 1878 the crop was 1,390,000 bushels, of which Virginia raised 875,000; Tennessee, 425,000, and North Carolina, 90,000 bushels.

In 1879 there was a large increase in the area planted, and estimated at 12 per cent. for the whole country. The yield also was greater, thus making a crop, according to commercial estimates, of 1,725,000 bushels. The weight per bushel varies in different localities, and is from 22 to 28 pounds per bushel. The value is about $1.15 per bushel, thus making a value of $1,983,750 for the crop of 1879.

CRANBERRY.

The American cranberry (*Vaccinium macrocarpon*) is found in a wild state in boggy land throughout the northern portions of the United States and Canada. The cultivation of the cranberry was commenced in the early part of the present century, but till thirty years ago was on a very limited scale; the first culture was in the vicinity of Cape Cod. The crop of the country is divided into three divisions, namely, the New England, New Jersey, and the Western. The New England crop includes all raised in the New England States, three-fourths of which is raised in the vicinity of Cape Cod; the Western crop includes that gathered in Michigan, Wisconsin, Minnesota, Iowa, and Northern Ohio and Indiana. The following table is extracted from the report of N. R.

French, esq., statistician of the New Jersey Cranberry Growers' Association, and gives the estimate of the crop for the last five years. To his estimates of the New Jersey crop is added the small crop of New York, which averages 4,000 bushels a year.

	1875.	1876.	1877.	1878.	1879.
	Bushels.	*Bushels.*	*Bushels.*	*Bushels.*	*Bushels.*
New England	75,000	65,000	164,229	125,000	165,000
New Jersey	115,000	93,000	157,100	63,000	78,000
Western	40,000	40,000	79,500	107,769	75,000
Total	230,000	198,000	400,829	295,769	318,000

It will be seen from the above table that the production varies greatly each year; per consequence, the price per bushel shows annually a corresponding fluctuation. The crop of 1879 was a very large one in New England, and ripened very early; the market in the East was overstocked, and prices fell as low as $4.50 per barrel. Later in the season the price rallied, and was $2.50 to $3 per bushel. The yield of cranberries is from 50 to 300 bushels per acre; the latter, however, is on land exceptionally productive. A fair average for the whole country is 110 bushels per acre. For preservation and facility of handling they are generally picked in crates of one bushel each. The following is the size adopted by the cranberry association of New Jersey: Bushel crate, $8\frac{3}{4} \times 12 \times 22$ inches.

FARM LABOR AND WAGES.

The following table of wages paid for labor in the farming districts of the United States was compiled from returns made in the month of April, 1880, and is placed in the report of this year. Apparently it should be in the report of 1880; but as the returns are made in the spring following the date of the report and before the funds to print the report of that year are available, it is deemed best to place the facts before the public at as early a day as possible, and not wait till after the close of the year. The same explanation applies to the table of labor and wages published in the report of 1878, and which was the rate of wages for April, 1879.

Average wages for 1880.

STATES.	PER MONTH.		PER DAY.								
	By the year.		Transient in harvest.		Transient not in harvest.		Carpentering.	Blacksmithing.	Wheelwrighting.	Machine-making.	Shoemaking.
	Without board.	With board.	Without board.	With board.	Without board.	With board.	Without board.	Without board.	Without board.	Without board.	Without board.
Maine	$21 00	$12 78	$1 50	$1 12	$1 09	$0 75	$1 86	$1 85	$1 87	$2 09	$1 54
New Hampshire	21 45	13 31	1 38	1 06	1 26	94	1 94	1 92	1 86	2 00	1 58
Vermont	19 12	12 62	1 46	1 10	1 00	69	1 87	1 77	1 75	2 03	1 65
Massachusetts	28 60	15 40	1 60	1 22	1 45	90	2 10	2 07	1 87	2 65	1 88
Rhode Island	19 00	......	1 00	75	......	50	1 50	1 50	1 50	......	......
Connecticut	23 40	14 00	1 75	1 34	1 06	71	2 00	2 08	1 95	2 50	1 85
New York	20 80	13 98	1 60	1 20	1 08	74	1 93	1 80	2 06	2 03	1 70
New Jersey	21 58	12 75	1 77	1 43	1 07	76	1 96	2 00	2 00	2 08	1 63
Pennsylvania	20 25	12 60	1 47	1 11	99	68	1 71	1 60	1 80	1 95	1 47
Delaware	16 00	10 00	1 00	75	50	33	1 50	2 00	1 50	2 00	1 25
Maryland	14 72	9 23	1 40	1 06	80	53	1 76	1 77	1 73	2 12	1 68
Virginia	12 30	8 25	1 18	93	64	45	1 60	1 57	1 60	1 75	1 33
North Carolina	11 92	8 10	1 09	84	61	45	1 66	1 60	1 63	2 02	1 20
South Carolina	10 38	7 32	1 14	88	55	43	1 54	1 64	1 65	2 20	1 36
Georgia	11 16	8 21	1 03	82	61	46	1 86	1 81	2 00	2 50	1 58
Florida	15 76	10 68	98	73	83	62	2 08	2 24	2 27	2 72	1 84
Alabama	12 87	8 87	1 10	86	72	51	2 10	1 99	2 31	2 79	1 53
Mississippi	13 55	9 80	1 10	84	76	54	2 12	2 30	2 37	2 68	1 82
Louisiana	16 62	12 26	1 03	74	89	65	2 47	2 55	2 53	3 10	2 10
Texas	17 48	12 09	1 25	95	92	67	2 25	2 30	2 25	2 84	2 05
Arkansas	17 61	11 73	1 32	1 04	85	65	2 18	2 15	2 21	2 37	1 77
Tennessee	13 08	9 13	1 40	1 08	75	52	1 82	1 74	1 95	2 32	1 56
West Virginia	18 45	11 77	1 13	80	83	59	1 79	1 74	1 72	2 00	1 45
Kentucky	16 28	10 75	1 48	1 14	77	53	1 96	1 84	1 94	2 29	1 52
Ohio	21 02	13 95	1 68	1 30	1 04	75	2 02	1 98	2 19	2 33	1 67
Michigan	23 90	15 68	2 07	1 63	1 20	86	1 97	1 91	2 13	2 24	1 67
Indiana	21 37	14 15	1 77	1 39	97	73	1 91	1 87	1 98	2 26	1 67
Illinois	22 11	14 97	1 73	1 37	1 10	82	2 03	2 03	2 12	2 25	1 70
Wisconsin	22 03	14 76	1 98	1 57	1 13	83	2 05	1 95	2 14	2 23	1 73
Minnesota	24 11	16 33	2 65	2 24	1 29	1 03	2 30	2 22	2 33	2 42	2 05
Iowa	23 26	13 74	2 01	1 57	1 16	86	2 02	2 01	2 13	2 35	1 83
Missouri	19 14	13 00	1 57	1 22	92	66	1 95	1 83	1 98	2 36	1 70
Kansas	21 78	13 43	1 66	1 27	1 08	76	2 10	2 06	2 17	2 32	1 87
Nebraska	24 48	14 52	1 94	1 56	1 09	86	2 20	2 19	2 45	2 33	1 96
California	40 93	27 12	2 21	1 71	1 95	1 27	3 36	3 15	3 50	3 83	2 74
Oregon	37 40	23 43	2 15	1 61	1 50	1 00	2 93	3 00	3 50	3 00	2 80
Nevada	......	30 00	2 00	1 67	1 90	1 32	4 33	5 00	5 33	5 75	5 00
Colorado	36 40	24 71	2 06	1 50	1 69	1 13	2 88	2 96	2 88	3 33	2 50
Utah	32 60	23 00	1 98	1 55	1 48	1 13	2 77	2 80	3 00	3 25	2 08
New Mexico	22 00	13 80	1 25	91	1 05	74	2 90	3 20	3 10	5 00	3 83
Washington	40 00	22 50	2 00	1 50	1 50	1 12	3 37	3 75	3 75	4 00	3 00
Dakota	27 17	18 10	2 33	1 97	1 41	99	2 42	2 68	2 64	3 03	2 39
Montana	42 65	30 75	2 87	2 25	2 17	1 50	4 00	3 62	3 81	3 83	3 83

A comparison of the returns in the first two columns of the above table with similar returns made last year gives a clear idea of the change in the value of labor since then. The decline which had been steadily going on since 1873 till last year seems to have been arrested, and there is a decided advance in almost every section. The average wage of labor engaged by the year or season, and which represents the steady and reliable force on the farm, was, for the whole country, last year, an average of $20.26 a month, without board. This year it is $21.75, being an increase of 7.25 per cent.

Taking into consideration the figures of the second column, being the rate paid with board to the same class of labor, we gain a clear view of the cost of subsisting the laborer, which, for the average of the whole country in 1880, is $7.17 a month against $7.14 in 1879. Heretofore

in the decline of wages the cost of subsistence declined in quite the same ratio, but for this year the proportion is largely in favor of the laborer, as the cost of subsistence remains nearly at the lowest rate, while the wage has materially advanced. The average price for labor, with board, is $14.56. An analysis of the figures in the first column shows only three States reporting less than last year, viz, Texas, Minnesota, and California; but a glance at the second column, or the wage paid with board, shows a marked increase. It must be borne in mind, however, that in all these States the sparseness of population and absence of the facilities of the older States render it both necessary and convenient to lodge and feed the hired help. The price paid, therefore, with board, is the safest indication of the value of labor in those States.

As was to be expected the greatest increase has been in those States where agriculture had been the most remunerative since last year. Thus in the West and those States bordering on the Ohio River, which were the most favored, the increase has been the largest. The same applies to the cotton States. With the higher price for cotton, the advance has been universal, and is in some sections as high as 8 or 10 per cent. The demand for labor is good in all sections of the country. In the New England and Middle States there is a steady and good demand for reliable men, and prices for that class have advanced very materially. The larger number of reports from these sections state that the usual custom is to hire with board and for the season.

In the South Atlantic and Gulf States there is an active demand for all kinds of steady labor. Many correspondents report that the share system, or a division of the product in lieu of wages, was growing more unpopular daily, and that the freedmen are becoming more and more landholders. In Mississippi and Louisiana there are a few reports of scarcity of labor, owing to the exodus to Kansas and the North, but in the same localities there is reported a good demand for reliable labor of all kinds. In the Northwestern States the supply of labor is quite equal to the demand. In that section most of the inhabitants are land-owners, and only hire help at harvest time, but skilled labor is reported in good demand. In the Territories and on the Pacific slope the demand is reported as good, except in New Mexico and Montana, where a surplus is noticed. In the first-named Territory the surplus is attributed to the opening of the railway from Kansas, and in the latter to the large number of young and unskilled laborers arriving.

VALUE OF LANDS.

In 1867 this department investigated the relative value of lands in the United States, and the results, in part, were published in the annual report of that year. The changes in the values of farm lands and of unimproved lands were carefully noted and compared. The following table shows the result of that comparison, or the changes that had taken place in farming estates from 1860 to 1867. No one will forget that these seven years embraced four years of devastating war, in the destructive ravages of which a large portion of our country was directly involved.

Change in the value of farm lands from 1860 to 1867.

States.	Increase.	Decrease.	States.	Increase.	Decrease.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Maine	10	....	Mississippi	....	[illegible]
New Hampshire	17	....	Louisiana	....	70
Vermont	17	....	Texas	....	13
Massachusetts	17	....	Arkansas	....	[illegible]
Rhode Island	18	....	Tennessee	....	18
Connecticut	20	....	West Virginia	[illegible]	....
New York	28	....	Kentucky	10	....
New Jersey	30	....	Missouri	[illegible]	....
Pennsylvania	25	....	Illinois	[illegible]	....
Delaware	66	....	Indiana	[illegible]	....
Maryland	20	....	Ohio	32	....
Virginia	....	27	Michigan	70	....
North Carolina	....	50	Wisconsin	[illegible]	....
South Carolina	....	60	Minnesota	150	....
Georgia	....	55	Iowa	75	....
Florida	....	55	Kansas	150	....
Alabama	....	60	Nebraska	175	....

As 1867 was the second year after the close of the war and after its losses had been partially recuperated, the facts did not fully reveal the disasters that had fallen upon the States in rebellion, but enough was still painfully evident to emphasize this great lesson of history. Every one of the so-called Confederate States showed great depreciation in farm values, which even the inflated currency of that period did not cover up. The decline was greatest in those States in which slave labor had been pushed to greatest extremes and in which the social ideas based upon it still exercised the most influence over the people. In North and South Carolina, Georgia, the Gulf States, and Arkansas the value of lands in 1867 was less than half that of 1860. Virginia and Tennessee had received a large class of agricultural and other immigrants from the North, and had thus largely repaired their losses.

Texas had suffered very little from actual operations of war and had also received a large accession of industrial population from all parts of the country, hence in this State the depreciation of value was much less. Of former slave States adhering to the Union, Kentucky and Missouri both show a decline in values, which may be accounted for by the destructive warlike operations within their borders. Maryland and Delaware showed a marked increase in values, both being mostly protected from hostile invasion. All the other States show a great advance, especially in the States west of the Mississippi River, whither the tide of settlement had been turned. With the exception of these general facts the information resulting from the investigation of 1867 was mostly local and fragmentary. The chaotic condition of the South was evident from the amount of land formerly returned as cultivated land that had been relegated to the class of wild or unimproved land. The resources of the Great West were beginning to be understood, and the old movement of migration to the wilderness still continued. The South, though offering vast areas of wild land, much of it government land at the minimum price, was unable to attract either Northern or foreign immigrants to any great extent. While those old Southern commonwealths were slowly recovering from the wounds and bruises of the great struggle, the Western States were filling up their vast unoccupied areas and new States were being erected out of the public domain. The movement of inter-State migration was of the same general character at the close of the war as in previous years.

The question of inter-State movement has pressed more and more weightily upon the intelligent minds of our people with every year since

the close of the civil war. The correspondence of the department shows an increasing desire to ascertain the facts and principles which have regulated this movement in the past, and whether a more advantageous direction could be given it for the future. To meet this general desire, the Commissioner of Agriculture ordered a statistical investigation of the facts attainable on this question. A circular, returnable May 15, 1879, was sent to our regular correspondents, in which were embraced inquiries as to the extent and value of unoccupied land, cleared or timbered, the facilities for travel, transportation, and marketing of products, educational and church facilities, the number and class of immigrants and the States and countries from which they came, the customs and terms of leasing lands, &c.

It was desirable to know how far inducements to the migration of the agricultural classes rested upon land open to appropriation elsewhere; hence the first point of inquiry was the amount of such lands in the different States. This inquiry referred to lands held by the national and State governments. In regard to the former, the inquiry narrowed itself down to what are called the public land States.

Inasmuch as the General Land Office at Washington, with its own records from the commencement of its operation, has declared its inability to state the amount of land remaining at its disposal, we did not expect our correspondents to be able to supply this information.

The public lands of the United States originally embraced the States north of the Ohio River, and the States and Territories between the Mississippi River and the Pacific Ocean, except Texas, together with Florida, Alabama, and Mississippi.

The title to unoccupied lands in these States and Territories was either granted by individual States to the Union after the Revolution or acquired by treaty, purchase, or conquest since the administration of President Jefferson.

According to the report of the Commissioner of the General Land Office for 1878, the total area of the public domain was 1,814,772,648 acres, of which 724,311,447 acres had been surveyed, leaving 1,090,461,171 acres unsurveyed. Some of the unsurveyed lands are covered by inchoate titles that will inure to railway corporations and pre-emption settlers upon the completion of survey, but the great mass of these unsurveyed lands are, as yet, entirely uncovered by any private claims, and are consequently open to settlement. Of the above area of unsurveyed lands, 369,529,600 acres are in Alaska, of which a former Commissioner of the General Land Office, Mr. Joseph S. Wilson, estimated that about 20,000 square miles or 12,800,000 acres are fit for some kind of agricultural settlement; this is about half the area of Ohio. A large portion of the unsettled land west of the Mississippi River consists of broken mountain country and of arid alkali soil unfit for cultivation by any process now known. The Indian Territory, embracing 44,154,240 acres, is reserved for the occupancy of Indian tribes, and hence is not open to white settlement. Making all deductions, it is safe to estimate that of the unsurveyed lands there remain 500 million acres suitable for profitable culture and uncovered by private title of any kind.

Of the surveyed lands it is difficult to form anything like a satisfactory estimate. The public surveys have been completed in the States north of the Ohio River, in Alabama, Mississippi, and in all the States just west of the Mississippi River except Minnesota.

Our correspondents in these States report quite large bodies of unoccupied land. In Alabama there are 91,000 acres of United States land in

Crenshaw County, 85,000 in Monroe, 100,000 in Franklin, 46,000 in Conecuh, and smaller tracts in others. In Mississippi, Scott County reports 42,000 acres; Lauderdale, 40.000; and Winston, 30,000. In Florida, where 7,827,724 acres are still unsurveyed, Clay County reports 140,000 acres; Santa Rosa, 87,000; the southern counties, embracing the "everglades," have been to a small extent appropriated by private parties, though large areas have been donated to the State as "swamp lands." Louisiana has 1,229,396 acres yet unsurveyed. Our correspondent reports 130,000 acres in Bienville, 29.000 in Claiborne, and smaller tracts in other parishes. In Arkansas vast tracts of government land, all surveyed, are open to settlers; about half of Garland County, 300,000 acres in Van Buren, 100,000 in Pike, and large bodies in other counties. These Southern States probably still contain from 15 to 20 million acres of United States land open to settlers under the land laws, by purchase, pre-emption, and homestead titles. North of the Ohio River the government title has been extinguished to all lands in Ohio, Indiana, and Illinois, except a few isolated small tracts of refuse land. In Northern Michigan several counties still report vast bodies; Chippewa, 500,000 acres; Delta, 100,000; Alcona, 30,000, &c. Very large tracts are found in Northern Wisconsin; Oconto and Lincoln Counties are supposed to have upwards of a million acres; in the southern counties also large bodies are found unoccupied. In the absence of definite statistics it may be safe to estimate the amount of government land in these States uncovered by private titles at from five to seven million acres.

West of the Mississippi River, Minnesota, Nebraska, and Colorado still embrace 67,884,579 acres of unsurveyed land, Iowa, Missouri, and Kansas having completed their surveys. The total amount of surveyed land in these six States is 230,104,921 acres. Of this area a very large amount has been donated to States and railway corporations, and a very large area taken by private claimants. It is not unreasonable, however, to estimate that about 100,000,000 acres, or one-third the area of these States, remains at the disposal of the general government.

In the Territories of Dakota, Wyoming, New Mexico, Utah, Idaho, and Montana, embracing an area of 438,119,680 acres, about six-sevenths, or 373,748,118 acres, remain unsurveyed, but of this area a considerable amount will inure to railway corporations as soon as the surveys are completed. Probably 250,000,000 acres of land suited to agricultural settlement yet remain at the disposal of the government.

On the Pacific slope three States, California, Oregon, and Nevada, and two Territories, Arizona and Washington, covering in all 351,408,000 acres, about five-sevenths, or 250,290,564 acres, remain unsurveyed. Individual or corporate title has attached to an area about equal to the surveyed lands, but of the remainder a large proportion is covered with mountain ranges, or with an arid climate, rendering it unfit for any kind of farming except, perhaps, sheep farming.

In regard to lands at the disposal of the different States, the information is less general or specific. None of our correspondents found any such lands available for private settlement in the New England or Middle States. Craig County, Virginia, reports 2,000 acres. State lands undisposed of are also reported in several counties of North Carolina, viz, Pamlico, Hyde, Graham, Bladen, Caldwell, Allehgany, Camden, Henderson, Tyrrel, Wilkes, and Montgomery. Similar reports from Beaufort, Colleton, and Clarendon, in South Carolina. Camden, Georgia, reports 60,000 acres.

All the Gulf States report considerable bodies of State land disposable in different counties. Texas on her accession to the Union stipu-

lated for the possession of her own public lands, and has consequently an immense domain open to settlement. The other Gulf States were all erected out of the public domain, and have been endowed by the general government with various land grants under the educational, swamp land, and other laws. Of the Southern inland States, only Arkansas is a public-land State, and hence has had numerous grants from the general government, of which a considerable portion remains unsold. In Tennessee, where the unoccupied lands had been ceded to the Union by North Carolina, the lands were found so covered by contradictory private claims that the general government ceded them to the State of Tennessee. From our returns we conclude that the mass of these lands have passed into private ownership, as only two counties, Fentress and Meigs, note any remnant within their borders. West Virginia and Kentucky report no lands of this character.

In Ohio no State land is reported; in Indiana our correspondent in Jasper County reports 40,000 acres. In Northern Michigan large bodies of State lands are yet undisposed of. Wisconsin has largely disposed of her lands, yet several counties report from 10,000 to 20,000 acres. Minnesota has a large amount of State land undisposed of; only half the county of Crow Wing has passed into private ownership. Iowa has mostly disposed of her State lands. Considerable tracts are scattered through Missouri; but Kansas, Nebraska, and Colorado present very large areas. The Territories have received but small endowments as yet, and consequently have but little to offer. On the Pacific coast numerous tracts of State land await disposal.

Of lands granted for rail and wagon road construction the total area is 198,165,704 acres, of which 59,306,591 were granted to fourteen States, viz, Illinois, Mississippi, Alabama, Florida, Louisiana, Arkansas, Missouri, Iowa, Michigan, Wisconsin, Minnesota, Kansas, California, and Oregon, in behalf of railways chartered by them. To the corporations commonly known as the Pacific roads were granted about 135,000,000 acres. The locality of many of the later donations cannot be determined till the public surveys along their lines shall have been completed. The endowments vary in amount. The earlier roads, such as the Illinois Central, were allowed the odd-numbered sections within six miles on either side of the road, and selections of odd-numbered sections between that limit and fifteen miles to replace sections within six miles to which prior rights had attached. In some of the later grants the limits of the original and reserve tracts were increased to 20 and 30 miles respectively. Some of these grants have lapsed through failure of the grantees to comply with the conditions required by law. Of the above aggregate, 3,857,218 acres were granted to three States, viz, Wisconsin, Michigan, and Oregon, for military and wagon roads.

Of unoccupied lands belonging to individuals, vast areas are reported in all sections of the Union. In the mountain and forest regions of the older States, for instance, we are informed that from half to three-fourths of whole counties are held, without occupation or cultivation of any kind, by private parties. Much of this represents valuable mineral lands, and other woodlands largely on mountain slopes. Such lands are to a small extent available for agriculture. There is no doubt that in a great many instances men have more real estate than they can profitably manage, and that many eligible farm tracts are available to purchasers from this source. Our reports, however, are too fragmentary to admit of tabulation.

The prices of farm lands, both cleared and timbered, were made sub-

ject of inquiry in several different investigations. The following table shows the results of those inquiries for 1880:

States.	Average value per acre of cleared lands in 1880.	Average value per acre of timbered lands in 1880.	Average increase in value of both classes in one year.
			Per ct.
Maine	$12 87	$12 66	10
New Hampshire	15 00	32 00	10
Vermont	15 28	17 73	6
Massachusetts	85 00	43 25	8
Rhode Island*	......	......	.....
Connecticut	29 00	24 50	7
New York	58 48	40 88	4.7
New Jersey	82 42	56 82	5.2
Pennsylvania	45 75	29 70	7
Delaware	19 00	15 00	7.5
Maryland	24 65	35 50	6.3
Virginia	9 42	7 48	1.4
North Carolina	9 77	5 53	6
South Carolina	8 64	6 24	9
Georgia	6 93	5 45	10
Florida	9 48	3 03	28
Alabama	6 53	4 08	9
Mississippi	7 88	3 78	9
Louisiana	14 36	3 53	9
Texas	8 98	4 00	4.8
Arkansas	11 78	3 48	7.3
Tennessee	13 00	7 28	8.7
West Virginia	21 05	9 39	8
Kentucky	18 86	12 82	8.2
Ohio	47 53	41 87	8.5
Michigan	34 39	20 27	8
Indiana	30 46	26 90	8.7
Illinois	33 03	23 68	11
Wisconsin	26 07	19 55	7
Minnesota	14 45	12 25	5
Iowa	27 36	39 36	7.5
Missouri	14 52	8 25	12.5
Kansas	11 82	19 12	10.3
Nebraska	8 93	25 85	15.3
California	27 16	8 55	3.2
Oregon	21 71	4 50	2.6

*No report.

It will be observed that every State shows an increased average value. A few counties report no change and still fewer a decline. The average for the whole country is 8 per cent. increase. New England reports an increase of 8 per cent. Timber lands here show a tendency to advance in relative value, showing a growing scarcity of this kind of lands. In New Hampshire and Vermont the average value of timbered lands exceeds that of cleared lands, while in Maine there is comparatively little difference. In the three Southern States of this section wood lands are comparatively lower. The proportion of urban to rural property and population is so much greater, that the value of land depends more upon its market crops.

In the Middle States the average value of both classes of land has advanced 5 per cent. The total area here is more than double that of New England. The advance in prices is mostly caused by the extension of mining and manufacturing and is felt more strongly near the centers of those branches of industry. Timber land also commands a higher price. In the oil regions quite an area supposed to be rich in petroleum is held by speculators for higher prices.

The South Atlantic States have advanced their land values 6 per

cent. Many counties report a very considerable appreciation from various causes. The increase in tobacco culture, the abundance and high price of the last cotton crop, manufacturing and mining enterprises, &c., are mentioned as among the causes of this improvement.

The Gulf States estimate a rise of 8 per cent. The Florida figures, 28 per cent., are believed to be excessive, but the small area of farm-land compared with other States in this section, renders this excess of little importance in the general estimate. On the other hand, the estimate of Texas, 4.8 per cent., is evidently too low. In Florida vast areas of timber land are just coming into market, and the special value of the land depends not upon its adaptability for agriculture as for the timber to be cut off it. In all these States are large amounts of public lands available for settlement and purchase from the government. In the western counties the exodus of African laborers has caused some reaction and caused some lands to be thrown upon the market. The yellow fever also had its reactive influence. In several counties a rapid denudation of timber lands is noted.

The Southern inland States claim an improvement of 9 per cent. In Arkansas the rapid increase of population and settlement will account for this improvement. In Tennessee and West Virginia there has been a considerable increase in the mining population and in mining enterprise. The removal of colored laborers to Kansas has caused an influx of white labor. In these and in other Southern States it is noted that the freedmen are becoming land-owners to an extent hitherto unexpected.

North of the Ohio the enhancement in the value of lands was about 9 per cent. An increased demand for real estate has sprung up under the operation of several causes. Mineral and manufacturing enterprise are advancing in different parts of this region, the latter at giant strides; but the advance in prices of farm lands in this region is evidently due to the immense crops of 1879. Several correspondents complain that timber land is becoming scarce, yet in all these States cleared land bears a higher average price.

West of the Mississippi River farm lands increased 10 per cent. in value. In the prairie States—Iowa, Kansas, and Nebraska—timber land bears a higher price than cleared land, and in these States a very considerable effort has been made to plant lands in timber. The rapid increase in population, together with the extension of manufacturing enterprise in these States, will account for the increase in farm values.

The Pacific States show but 3 per cent. increase. The effect of the late labor agitation in California is seen in this fact. This agitation, however, has measurably quieted down. Several of our correspondents reflect at some length the aspects of local opinion and feeling on the Chinese labor question. The peculiar character of this labor tends to create a disturbance in the general labor market. How it is to be adjusted does not appear from any facts yet developed. Late events on the Pacific coast show a tendency in this class of laborers to diffuse themselves over the whole country and not to locate in that section exclusively. In many respects this is desirable. The disturbing influence of this cheap labor will be felt far less if diffused over the whole country.

The above exhibits some of the leading laws and causes regulating the problem of inter-State migration and settlement in our country, as developed by our late investigations. We have presented already such generalizations as the present state of the inquiry will bear. It is a question which demands a continued annual investigation, and from which good results may be anticipated.

OUR AGRICULTURAL EXPORTS.

Statement of the exports of agricultural products of the United States, with their immediate manufactures, for the two fiscal years ending June 30, 1879, compiled from the Treasury report of commerce and navigation.

Products.	1878.		1879.	
	Quantity.	Value.	Quantity.	Value.
Animals, living:				
Hogs .... number..	29, 284	$267, 259	75, 129	$700, 262
Horned cattle .... do....	80, 040	3, 896, 813	136, 720	8, 379, 200
Horses .... do....	4, 104	798, 728	3, 915	770, 742
Mules .... do....	3, 860	501, 513	4, 153	530, 989
Sheep .... do....	183, 995	333, 499	215, 630	1, 082, 938
All other, and fowls .... do....	....	46, 841	....	23, 623
Animal matter:				
Bone-black, ivory-black, &c ..... pounds..	2, 738, 784	80, 740	1, 026, 127	48, 347
Bones and bone-dust .... cwt..	47, 429	78, 989	42, 393	70, 800
Candles .... pounds..	1, 567, 265	218, 985	1, 815, 699	225, 104
Furs and fur-skins	....	2, 618, 100	....	4, 828, 158
Glue .... pounds..	250, 563	31, 247	394, 097	43, 779
Hair:				
Unmanufactured	....	361, 348	....	279, 170
Manufactures of	....	30, 283	....	18, 629
Hides and skins, other than furs	....	1, 286, 840	....	1, 171, 523
Leather:				
Sorts not specified .... pounds..	28, 389, 140	6, 189, 052	28, 719, 623	5, 846, 882
Morocco, and other fine	....	903, 968	....	953, 188
Boots and shoes .... pairs..	351, 152	468, 436	329, 355	402, 557
Saddlery and harness	....	127, 000	....	132, 699
Other manufactures	....	391, 574	....	433, 743
Oil:				
Lard .... gallons..	1, 651, 648	994, 440	1, 963, 208	1, 037, 923
Other animal .... do....	19, 823	17, 447	145, 641	134, 832
Provisions:				
Bacon and hams .... pounds..	592, 814, 351	51, 752, 068	732, 249, 576	51, 074, 433
Beef: Fresh .... do....	54, 046, 771	5, 009, 856	54, 025, 832	4, 883, 080
Salted .... do....	38, 831, 379	2, 973, 234	36, 950, 563	2, 336, 378
Butter .... do....	21, 837, 117	3, 931, 822	38, 248, 016	5, 421, 205
Cheese .... do....	123, 783, 736	14, 103, 529	141, 654, 474	12, 579, 968
Condensed milk	....	128, 284	....	119, 883
Eggs .... dozen..	94, 265	14, 880	91, 740	14, 258
Lard .... pounds..	342, 667, 920	30, 014, 254	326, 658, 686	22, 856, 673
Mutton, fresh .... do....	130, 582	9, 272	1, 440, 197	123, 013
Pork .... do....	71, 889, 255	4, 913, 657	84, 401, 676	4, 807, 568
Preserved meats	....	5, 102, 625	....	7, 311, 408
Soap:				
Perfumed and toilet	....	36, 272	....	30, 827
All other .... pounds..	10, 910, 742	621, 867	12, 297, 689	621, 311
Tallow .... do....	85, 505, 919	6, 695, 377	99, 963, 752	6, 934, 940
Wax .... do....	326, 613	95, 074	168, 745	45, 823
Wool:				
Raw and fleece .... pounds..	347, 854	93, 358	60, 784	17, 644
Carpets .... yards..	10, 626	10, 430	8, 133	8, 118
Other manufactures	....	438, 554	....	338, 615
Total value of animals and animal matter	....	$145, 587, 515	....	$146, 641, 233
Breadstuffs and other preparations:				
Barley .... bushels..	3, 921, 501	2, 565, 736	715, 536	401, 180
Bread and biscuit .... pounds..	14, 392, 231	730, 317	15, 565, 190	682, 471
Corn .... bushels..	85, 461, 098	48, 030, 358	86, 296, 252	40, 655, 120
Corn-meal .... barrels..	432, 753	1, 336, 187	397, 160	1, 052, 231
Oats .... bushels..	3, 715, 479	1, 277, 920	5, 452, 136	1, 618, 644
Rye .... do....	4, 207, 912	3, 051, 739	4, 851, 715	3, 103, 970
Rye-flour .... barrels..	6, 962	30, 775	4, 351	15, 113
Wheat .... bushels..	72, 404, 961	96, 872, 016	122, 353, 936	130, 701, 079
Wheat-flour .... barrels..	3, 947, 333	25, 095, 721	5, 629, 714	29, 567, 713
Other small grain and pulse	....	1, 077, 433	....	817, 536
Other preparations of grain	....	1, 709, 639	....	1, 740, 471
Rice .... pounds..	631, 105	33, 953	740, 136	35, 538
Total value of breadstuffs, &c	....	$181, 811, 794	....	$210, 391, 066
Cotton, and its manufactures:				
Sea Island .... pounds..	6, 325, 147	1, 616, 214	4, 030, 228	1, 108, 072
Other manufactures .... do....	1, 601, 208, 364	178, 415, 270	1, 624, 342, 605	161, 196, 178
Colored goods .... yards..	37, 765, 313	2, 959, 910	45, 116, 058	3, 209, 285
Uncolored .... do....	88, 528, 192	7, 053, 463	84, 081, 319	6, 288, 131
All other manufactures	....	1, 425, 287	....	1, 356, 534
Total value of cotton, &c	....	191, 470, 144	....	173, 158, 200

Statement of the exports of agricultural products of the United States, &c.—Continued.

Products.	1878.		1879.	
	Quantity.	Value.	Quantity.	Value.
Wood, and its products:				
Boards, planks, joists, &c. ....M feet..	313,143	[illegible]	275,102	$3,972,608
Laths, palings, pickets, &c. ....M..	3,050	[illegible]	4,476	13,[illegible]
Shingles ....M..	46,518	[illegible]	55,858	176,514
Box-shooks	....	[illegible]	....	103,783
Other shooks, staves, and heading	....	[illegible]	....	3,666,652
Hogsheads and barrels, empty..number..	82,402	159,420	148,604	248,085
All other lumber	....	520,454	....	650,068
Fire-wood ....cords..	2,837	9,469	3,444	11,096
Hop, hoop, telegraph, and other poles	....	377,137	....	460,209
Logs, masts, spars, and other whole timber	....	352,101	....	613,706
Timber, sawed and hewed....cubic feet..	18,361,915	2,662,784	13,255,241	1,743,525
All other timber	....	114,967	....	164,192
Household furniture	....	1,961,522	....	1,804,296
Woodenware	....	257,861	....	255,770
All other manufactures	....	1,714,440	....	1,690,992
Ashes, pot and pearl ....pounds..	679,862	[illegible]	1,[illegible],601	61,266
Bark, for tanning	....	111,365	....	130,939
Resin and turpentine ....barrels..	1,042,183	[illegible]	1,112,816	2,159,141
Spirits of turpentine ....gallons..	7,633,568	[illegible]	7,575,556	2,045,673
Tar and pitch ....barrels..	73,407	[illegible]	52,[illegible]	101,445
Total value of wood, &c.	....	21,747,117	....	20,122,967
Miscellaneous:				
Brooms, brushes, &c.	....	146,037	....	138,184
Cordage, ropes, and twine of all kinds ....pounds..	3,411,413	380,004	3,960,351	391,504
Fruits:				
Apples: Dried ....pounds..	4,188,173	[illegible]	7,379,836	296,794
Green or ripe ....bushels..	279,447	[illegible]	1,388,800	980,455
Other, green, ripe, or dried	....	[illegible]	....	252,415
Preserved, in cans or otherwise	....	[illegible]	....	336,718
Ginseng ....pounds..	421,395	497,247	391,264	465,611
Hay ....tons..	9,514	141,510	8,127	122,122
Hemp:				
Unmanufactured ....cwt..	2,325	18,210	1,281	8,155
Cable and cordage ....do....	11,402	146,043	16,182	170,179
All other manufactures	....	1,056,709	....	1,153,471
Hops ....pounds..	18,458,782	2,152,873	5,458,159	701,095
Liquors, alcoholic, cider and beer:				
Ale and porter:				
In bottles ....dozens..	76,475	108,279	125,873	204,282
In casks ....gallons..	119,579	38,918	93,014	34,987
Spirits, distilled from:				
Grain ....gallons..	2,258,401	864,162	7,052,366	2,262,150
Molasses ....do....	655,864	272,457	1,239,082	396,186
Other materials ....do....	12,386	12,653	20,309	12,955
Wine ....do....	46,614	38,775	46,224	49,775
Oil-cake ....pounds..	342,446,439	5,095,163	340,995,395	4,394,010
Oil:				
Cotton-seed ....gallons..	4,992,349	2,514,323	5,352,793	2,233,068
Linseed ....do....	38,901	27,232	30,416	22,297
Essential or volatile	....	323,341	....	242,329
Seeds:				
Cotton ....pounds..	16,757,634	179,602	16,[illegible]	141,188
Flax or lint ....bushels..	263	437	49	107
All other	....	2,085,887	....	2,141,533
Starch ....pounds..	12,995,385	605,521	14,298,654	601,797
Sugar:				
Brown ....pounds..	52,683	4,506	43,955	3,202
Refined ....do....	44,040,409	[illegible]	72,309,009	6,164,024
Molasses ....gallons..	1,477,057	[illegible]	4,727,367	919,173
Candy and confectionery	....	[illegible]	....	32,274
Tobacco:				
Leaf ....pounds..	283,973,193	24,803,165	322,279,540	25,157,364
Cigars ....M..	2,082	[illegible]	2,299	53,397
Snuff ....pounds..	13,344	[illegible]	13,522	5,846
Other manufactures	....	[illegible]	....	2,998,633
Vegetables, &c.:				
Onions ....bushels..	56,795	44,522	64,695	60,022
Pickles and sauces	....	[illegible]	....	12,908
Potatoes ....bushels..	744,409	[illegible]	[illegible]	545,109
All other	....	[illegible]	....	79,530
Vinegar ....gallons..	14,771	[illegible]	[illegible]	6,227
Total value of miscellaneous products	....	52,245,306	....	[illegible]

Statement of the exports of agricultural products of the United States, &c.—Continued.

RECAPITULATION.

Products.	1871.	1872.	1873.	1874.	1875.
Animals and animal matter	$47, 010, 512	$77, 0[illegible], 849	$99, 806, 599	$99, 607, 669	$104, 314, 9[illegible]8
Breadstuffs, &c	79, 519, 387	85, 155, 523	98, 762, 891	161, 225, 939	111, 478, 096
Cotton, &c	221, 885, 245	182, 988, 925	230, 190, 597	214, 319, 420	194, 710, 567
Wood, &c	15, 820, 029	21, 425, 063	25, 854, 120	27, 675, 300	22, 875, 814
Miscellaneous	33, 060, 081	40, 139, 296	37, 901, 458	45, 486, 626	45, 294, 411
Total agricultural exports	397, 2[illegible]54	40[illegible], 769, 691	492, 515, 665	548, 314, 954	478, 672, 816
Total exports	562, 518, 651	549, 219, 718	649, 132, 563	693, 039, 054	643, 094, 767
Per cent. of agricultural matter	70	74	76	79	74

Products.	1876.	1877.	1878.	1879.
Animals and animal matter	$113, 941, 569	$140, 564, 066	$145, 587, 515	$146, 641, 233
Breadstuffs, &c	131, 212, 471	118, 126, 940	181, 811, 794	210, 391, 066
Cotton, &c	200, 382, 240	183, 253, 248	191, 470, 144	173, 158, 200
Wood, &c	21, 620, 486	23, 422, 966	21, 747, 117	20, 122, 967
Miscellaneous	46, 079, 567	58, 652, 719	52, 245, 306	53, 843, 026
Total agricultural exports	513, 286, 273	524, 019, 939	592, 861, 876	604, 156, 492
Total exports	644, 956, 406	689, 167, 390	722, 811, 815	717, 093, 777
Per cent. of agricultural matter	79	76	82	84

It must be borne in mind that the values of 1879 are, with the exception of a few months, on a specie basis, while those of the preceding years are on a currency basis. Thus it appears at first glance that the total exports of the country had decreased, since June 30, 1878, from $722,811,815 to $717,093,777; whereas if taken on a specie basis there was an increase of 2½ per cent., and the figures would read for 1878, $680,709,268, and $698,340,790 for 1879, and an increase of $17,631,522. The increase in value of agricultural exports, as shown in the above tables, is very considerable, and shows a steady increase year by year. Thus the proportion of agricultural matter to the total export of the country is 84, against 82 per cent. last year, and 76 in 1877. The exports of dairy products show a great increase, and the following table will show the quantity and value exported since 1870. Fully three-fourths of the export is to Great Britain, the balance to British America and the West Indies:

Exports of dairy products.

Year ending June 30—	Butter.	Value.	Cheese.	Value.
	Pounds.		*Pounds.*	
1870	2, 019, 288	$592, 229	57, 296, 327	$8, 881, 934
1871	3, 965, 043	853, 096	63, 698, 867	8, 752, 990
1872	7, 746, 261	1, 498, 812	66, 204, 025	7, 752, 918
1873	4, 518, 844	952, 919	80, 366, 540	10, 498, 010
1874	4, 367, 983	1, 092, 381	90, 611, 077	11, 898, 995
1875	6, 360, 827	1, 506, 996	101, 010, 853	13, 659, 603
1876	4, 644, 894	1, 109, 496	97, 676, 264	12, 270, 083
1877	21, 527, 242	4, 424, 616	107, 364, 666	12, 700, 627
1878	21, 837, 117	3, 931, 822	123, 783, 736	14, 103, 529
1879	38, 248, 016	5, 421, 205	141, 654, 474	12, 579, 968

A good idea of the great advance of the country is given in the following table showing the exports of agricultural products since twenty years:

Product.	1859.	1869.	1879.
Animals and animal matter	$20, 081, 180	$36, 643, 895	$146, 641, 233
Breadstuffs	24, 046, 752	72, 302, 060	210, 391, 066
Cotton and its manufacture	169, 751, 045	230, 807, 951	173, 158, 200
Wood and its manufacture	13, 128, 054	13, 951, 326	20, 122, 967
Miscellaneous	27, 290, 938	35, 960, 749	53, 963, 201
Total	254, 297, 969	389, 647, 981	604, 276, 667

DISTRIBUTION OF OUR AGRICULTURAL EXPORTS.

ANIMALS AND ANIMAL MATTER.—Our exports of live animals present a value double that of the previous year. This increase is mostly in cattle and hogs. Cattle exports increased 71 per cent. in number, and 115 per cent. in value; hogs, 151 per cent. in number and 161 per cent. in value; horses fell off 5 per cent. in number, and 3 per cent. in value; mules increased 8 per cent. in number, and 6 per cent. in value; sheep 17 per cent. in number, and 225 per cent. in value; all other farm animals, including fowls, fell off 50 per cent. in value.

Of the export values, cattle represent 72.64 per cent.; hogs, 6.20; horses, 6.72; mules, 4.72; sheep, 9.52; other animals, 0.20. The United Kingdom took 71 per cent. of our entire export value; Continental Europe, 4.32 per cent; British North America, 9.15; Mexico, 1.28; Central and South America, 0.59; West Indies, 12.18; Japan, 0.10; other countries, 1.38.

The United Kingdom took $8,167,796 worth of live animals, against $3,175,330 last year; Continental Europe, $499,100, against $223,397; British North America, $1,053,592, against $747,654; Mexico, $149,827, against $196,321; Central and South America, $61,810, against $87,365; West Indies, $1,380,962, against $1,382,330; Japan, $14,500, against $9,190; other countries, $160,167, against $23,570; total, $11,487,754, against $5,845,157. There is a slight falling off in the value of exports to Central and South America and to the West Indies, but a heavy increase to Europe and especially the United Kingdom. The number of cattle, hogs, horses, mules, and sheep sent out of the country was nearly one-half greater than in 1878. The following table shows the distribution of this class of agricultural exports:

Animals.	United Kingdom.	Continental Europe.	British North America.	Mexico.	Central and South America.
Cattle:					
Number	71, 794	3, 264	8, 555	2, 145	128
Aggregate value	$6, 616, 114	$325, 120	$518, 135	$20, 325	$9, 024
Average value	$92 01	$99 61	$60 56	$9 48	$70 50
Hogs:					
Number	25, 033	700	48, 180	838	13
Aggregate value	$239, 484	$5, 700	$449, 111	$2, 321	$320
Average value	$9 13	$8 01	$9 32	$2 77	$2 46
Horses:					
Number	1, 683	485	317	506	122
Aggregate value	$410, 420	$145, 650	$55, 689	$16, 230	$19, 617
Average value	$243 86	$300 31	$175 67	$32 09	$160 79
Mules:					
Number	105	....	16	28	161
Aggregate value	$10, 750	....	$1, 705	$1, 720	$19, 835
Average value	$102 38	....	$106 56	$61 43	$123 20
Sheep:					
Number	108, 652	2, 700	9, 559	89, 689	2, 233
Aggregate value	$887, 701	$21, 400	$27, 949	$103, 789	$12, 540
Average value	$8 16	$7 92	$2 92	$1 16	$5 61
Other, aggregate value	$3, 327	$1, 230	$1, 003	$5, 442	$474
Total value to each country:					
1879	$8, 167, 796	$499, 100	$1, 053, 592	$149, 827	$61, 810
1878	3, 175, 330	223, 397	747, 654	196, 321	87, 365
Per cent. of values to each country:					
1879	71. 00	4. 32	9. 15	1. 28	0. 59
1878	54. 32	3, 82	12. 80	3. 36	1. 49

Animals.	West Indies.	Japan.	Other countries.	Total exports.	Per cent. of value of each kind of stock.
Cattle:					
Number	50,761	11	62	136,820	
Aggregate value	$881,697	$930	$7,855	$8,379,200	72.64
Average value	$17 37	$84 55	$110 56	$61 24	
Hogs:					
Number	251	....	114	75,129	
Aggregate value	$1,793	....	$1,533	$700,262	6.02
Average value	$7 14	....	$13 45	$9 32	
Horses:					
Number	739	11	52	3,915	
Aggregate value	$106,051	$5,025	$12,060	$770,742	6.72
Average value	$143 37	$456 82	$231 92	$196 87	
Mules:					
Number	3,056	....	787	4,153	
Aggregate value	$364,014	....	$132,965	$530,989	4.72
Average value	$119 11	....	$168 75	$125 69	
Sheep:					
Number	2,622	200	25	215,680	
Aggregate value	$20,939	$8,545	$75	$1,082,938	9.52
Average value	$7 99	$42 72	$3 00	$5 02	
Other, aggregate value	$6,468	....	$5,679	$23,623	0.20
Total value to each country:					
1879	$1,380,962	$14,500	$160,167	$11,487,754	100.00
1878	1,382,330	9,190	23,570	5,845,157	
Per cent. of values to each country:					
1879	12.18	0.10	1.38	100.00	
1878	23.65	0.16	0.40	100.00	

Of dead animal matter, pork and its preparations constitute about three-fifths of the total value. The average export values are more than 20 per cent. below those of 1878, but the great increase in quantities brings the aggregate value nearly up to the previous year. While the export of lard in quantity has fallen off 4 per cent., bacon and hams have increased 24 per cent., pork 18 per cent., and lard oil 20 per cent. The United Kingdom takes larger quantities of all kinds except lard, the increase in bacon and hams amounting to nearly a hundred million pounds; yet her total values have fallen off about 6 per cent. France falls off about one-fourth in her total value, and in her quantities of bacon, hams, and lard; she has trebled her quantity of pork, and doubled that of lard oil. Germany reduces her aggregate value nearly 10 per cent., but increases her quantities of all articles, except lard oil, which has fallen to about one-twelfth of last year's export. Belgium and Netherlands are liberal customers in this line, their aggregate value of exports having increased in spite of the heavy decline in prices. They enlarged their demand for bacon and hams about 60 per cent.; for lard, 12 per cent.; for pork, nearly 80 per cent.; and for lard oil, nearly double. With other European countries our trade has enlarged about 40 per cent. in total value, all the items in the table showing a heavy increase in quantity and a smaller increase in aggregate value. Our trade with Europe foots up $71,412,971, against $77,748,718 last year, a loss of about 8 per cent. Yet there is a very large increase in quantity in all except lard, which falls off about 10 per cent.

Our trade with British North America falls off about one-fourth in total value, and also declines in the quantities exported. With Mexico, Central and South America, and the West Indies, the aggregate value of exports also decreases, though the quantities are enlarged, except in bacon and hams, which show a considerable falling off. The trade to

other countries, which is but a small part of the whole, presents an increase both in quantity and aggregate value. The exports of hog products are distributed as follows:

Articles.	United Kingdom.	France.	Germany.	Belgium and Netherlands.	Other countries in Europe.
Bacon and hams:					
Pounds	516, 862, 581	53, 593, 720	37, 308, 897	89, 622, 804	18, 730, 113
Value	$38, 535, 923	$3, 248, 214	$2, 051, 712	$4, 984, 311	$907, 798
Average per pound	$0 07. 4	$0 06. 1	$0 05. 5	$0 05. 5	$0 04. 8
Lard:					
Pounds	89, 248, 618	42, 360, 456	89, 710, 334	40, 193, 957	7, 291, 504
Value	$6, 231, 799	$2, 877, 630	$6, 163, 503	$2, 750, 840	$500, 972
Average per pound	$0 06. 9	$0 06. 8	$0 06. 9	$0 06. 8	$0 06. 9
Pork:					
Pounds	30, 784, 739	2, 168, 614	919, 817	292, 930	174, 905
Value	$2, 032, 156	$140, 658	$52, 281	$17, 279	$9, 729
Average per pound	$0 06. 6	$0 06. 5	$0 05. 7	$0 05. 9	$0 05. 6
Lard oil:					
Gallons	1, 315, 672	337, 407	14, 490	77, 001	349
Value	$680, 194	$178, 271	$8, 379	$41, 120	$202
Average per gallon	$0 51. 7	$0 52. 9	$0 57. 8	$0 53. 4	$0 57. 9
Total value to each country:					
1879	$47, 480, 072	$6, 444, 773	$8, 275, 875	$7, 793, 550	$1, 418, 701
1878	50, 897, 497	8, 586, [illegible]	9, 678, 765	7, 536, 310	1, 080, 360
Per cent. to each country:					
1879	59. 45	8. 07	10. 37	9. 76	1. 78
1878	58. 02	9. 79	11. 04	8. 59	1. 23

Articles.	British North America.	West Indies.	Mexico, Central, and South America.	Other countries.	Total.	Per cent. of each product in value.
Bacon and hams:						
Pounds	3, 545, 586	10, 692, 407	1, 092, 626	600, 842	732, 249, 576	
Value	$279, 329	$397, 295	$102, [illegible]	$67, 167	$51, [illegible], 483	64. 00
Average per pound	$0 07. 9	$0 05. 3	$0 09. 4	$0 11. 1	$0 06. 9	
Lard:						
Pounds	2, 902, 429	31, 989, 874	21, 989, 744	971, 770	326, 658, 686	
Value	$201, 581	$2, 303, 702	$1, 740, 049	$86, 597	$22, 856, 673	28. 70
Average per pound	$0 06. 9	$0 07. 2	$0 07. 9	$0 08. 9	$0 06. 9	
Pork:						
Pounds	16, 968, 151	26, 670, 535	4, 847, 636	1, 574, 349	84, 401, 676	
Value	$811, 125	$1, 394, 697	$259, 757	$89, 866	$4, 807, 568	6. 02
Average per pound	$0 04. 8	$0 05. 2	$0 05. 4	$0 05. 7	$0 05. 7	
Lard oil:						
Gallons	40, 970	33, 749	105, 242	38, 328	1, 963, 208	
Value	$24, 221	$19, 199	$62, 705	$23, 632	$1, 037, 923	1. 28
Average per gallon	$0 59. 1	$0 56. 9	$0 59. 6	$0 61. 8	$0 52. 9	
Total value to each country:						
1879	$1, 316, 256	$4, 614, 893	$2, 165, 195	$267, 262	$79, 776, 597	100. 00
1878	1, 181, 149	5, 509, 433	2, 317, 371	213, 748	87, 674, 419	
Per cent. to each country:						
1879	1. 65	5. 78	2. 71	0. 34	100. 00	
1878	2. 15	6. 28	2. 64	0. 36	100. 00	

Beef products show a small decline in aggregate values, but the quantities of nearly all the articles exported are greater than last year. The price of fresh beef declined 3 per cent., salt beef 18, butter 21, cheese 29, tallow 15, glue 10, candles 12, leather 6. Neat's-foot oil advanced 5 per

cent., and increased its quantity from 19,823 gallons to 145,641. The following table will show the distribution of this class of products.

Articles.	United Kingdom.	France.	Germany.	Belgium and Netherlands.	Other European countries.
Fresh beef:					
Pounds	52,792,960	1,039,041	....	....	....
Value	$4,776,572	$96,934	....	....	....
Average per pound	$0 09.0	$0 09.2	....	....	....
Salt beef:					
Pounds	22,027,262	561,331	2,409,670	1,416,964	117,250
Value	$1,430,886	$39,368	$147,104	$83,681	$6,599
Average per pound	$0 06.5	$0 07.0	$0 06.1	$0 06.0	$0 05.6
Butter:					
Pounds	24,841,714	61,815	8,210,578	86,654	13,612
Value	$3,727,965	$9,749	$884,735	$13,832	$2,259
Average per pound	$0 15.1	$0 15.7	$0 10.7	$0 16.0	$0 16.6
Cheese:					
Pounds	136,603,242	27,273	410,827	19,473	3,188
Value	$12,122,379	$2,460	$33,740	$1,674	$296
Average per pound	$0 08.8	$0 09.0	$0 08.2	$0 08.6	$0 09.3
Condensed milk, value	$24,915	$85	$1,547	....	....
Tallow:					
Pounds	44,930,280	18,923,453	12,008,784	8,055,114	11,000,884
Value	$3,115,743	$1,296,210	$735,277	[illegible]	$756,819
Average per pound	$0 07.0	$0 06.8	$0 06.1	$0 07.1	$0 06.8
Glue:					
Pounds	100,894	....	71,200	122,650	....
Value	$10,799	....	$8,704	$10,139	....
Average per pound	$0 10.7	....	$0 12.2	$0 08.3	....
Hides, value	$133,964	$232,443	$250,711	$29,226	$600
Neat's-foot oil:					
Gallons	118,672	509	690	24,918	....
Value	$113,156	$410	$597	$19,892	....
Average per gallon	$0 95.2	$0 80.6	$0 86.6	$0 80.0	....
Candles:					
Pounds	360	....	470	....	12,532
Value	$58	....	$67	....	$1,832
Average per pound	$0 16.1	....	$0 14.3	....	$0 14.8
Leather:					
Pounds	18,669,743	26,899	7,536,200	1,471,479	110,728
Value	$3,609,679	$4,980	$1,630,721	$368,629	$22,894
Average per pound	$0 19.3	$0 18.5	$0 21.6	$0 25.0	$0 20.6
Morocco, value	$765,103	$1,033	$28,639	$84,385	....
Manufactures of leather, value	$113,245	$869	$117,891	$55,644	....
Total for each country:					
1879	$29,944,469	$1,684,541	$3,939,733	$1,240,485	$791,299
1878	31,737,390	1,803,804	2,997,843	1,492,466	635,564
Per cent. to each country:					
1879	71.96	4.05	9.47	2.98	1.90
1878	74.70	4.26	6.84	3.51	1.48

Articles.	British North America.	West Indies.	Mexico, Central and South America.	Other countries.	Total for each product.	Per cent. of value of each product.
Fresh beef:						
Pounds	187, 502	5, 420			54, 025, 832	
Value	$9, 032	$542			$4, 883, 080	11. 73
Average per pound	$0 04. 9	$0 10. 0			$0 09. 0	
Salt beef:						
Pounds	2, 014, 950	4, 804, 067	2, 153, 090	1, 444, 979	36, 950, 563	
Value	$107, 773	$313, 370	$135, 056	$62, 541	$2, 326, 378	5. 59
Average per pound	$0 05. 3	$0 06. 5	$0 06. 2	$0 04. 3	$0 06. 3	
Butter:						
Pounds	824, 373	2, 728, 851	959, 458	520, 961	38, 248, 016	
Value	$102, 073	$384, 628	$182, 497	$113, 467	$5, 421, 205	13. 28
Average per pound	$0 12. 4	$0 14. 1	$0 19. 0	$0 21. 7	$0 14. 2	
Cheese:						
Pounds	2, 876, 351	1, 145, 696	380, 000	188, 424	141, 654, 474	
Value	$231, 667	$123, 246	$40, 396	$24, 110	$12, 579, 968	30. 25
Average per pound	$0 08. 1	$0 10. 8	$0 10. 6	$0 12. 8	$0 08. 9	
Condensed milk, value	$3, 480	$22, 140	$17, 421	$50, 295	$119, 883	0. 29
Tallow:						
Pounds	1, 839, 035	597, 155	2, 265, 857	243, 190	99, 963, 752	
Value	$114, 004	$42, 430	$174, 869	$26, 200	$6, 934, 940	16. 44
Average per pound	$0 06. 2	$0 07. 1	$0 07. 7	$0 07. 6	$0 07. 0	
Glue:						
Pounds	64, 692	12, 537	13, 897	8, 227	394, 097	
Value	$9, 130	$2, 051	$2, 085	$871	$43, 779	0. 10
Average per pound	$0 14. 1	$0 16. 3	$0 15. 0	$0 10. 5	$0 11. 1	
Hides, value	$499, 031	$43	$2, 243	$23, 262	$1, 171, 523	2. 80
Neat's-foot oil:						
Gallons	126	34	99	583	145, 641	
Value	$89	$32	$97	$559	$134, 832	0. 30
Average per gallon	$0 70. 6	$0 94. 1	$0 79. 1	$0 96. 0	$0 92. 5	
Candles:						
Pounds	83, 811	961, 191	729, 465	28, 050	1, 815, 699	
Value	$10, 505	$115, 578	$93, 465	$3, 599	$225, 104	0. 54
Average per pound	$0 12. 5	$0 12. 0	$0 12. 8	$0 12. 8	$0 12. 4	
Leather:						
Pounds	481, 371	46, 108	35, 246	341, 849	28, 719, 623	
Value	$112, 523	$9, 859	$8, 926	$78, 671	$5, 846, 882	14. 06
Average per pound	$0 25. 4	$0 21. 4	$0 25. 3	$0 23. 0	$0 20. 4	
Morocco, value	$6, 145	$12, 816	$14, 768	$40, 299	$953, 188	2. 30
Manufactures of leather, value	$120, 166	$139, 580	$238, 674	$182, 930	$968, 999	2. 36
Total for each country:						
1879	$1, 325, 618	$1, 166, 315	$910, 497	$606, 804	$41, 609, 761	100. 00
1878	1, 261, 489	1, 236, 509	810, 611	585, 973	42, 476, 651	
Per cent. to each country:						
1879	3. 19	2. 80	2. 19	1. 46	100. 00	
1878	2. 98	2. 92	1. 91	1. 40	100. 00	

The United Kingdom is our largest customer for the class of articles represented in the above table, though her proportion of the total value shows some decline. European countries taken together absorb about the same proportion of our beef products as last year, a little over 70 per cent., and the other parts of the world less than 30 per cent. The United Kingdom takes a little less beef, fresh and salt, but increases her demand for butter, cheese, tallow, and leather. Several minor items also show some increase. France took more beef, butter, and tallow, but the other items fell off. Germany has not yet called upon us for fresh beef, but has increased her demand for salt beef, butter, cheese, tallow, and leather. Belgium and Netherlands take more salt beef, cheese, and leather, but less of butter and tallow. The other European countries take less beef and leather, but more butter, cheese, and tallow. The British North American trade has considerably enlarged on the whole; all the leading staples were sent out in increased quantities except butter. Our trade with the West Indies shows some decline in total values but an increase

in the quantities of several articles. The American continent south of us has increased both in total value of exports and in the quantities of several leading items. The other countries of the world likewise show an increased appreciation of our agricultural staples. On the whole, our beef products have fully held their own in quantity, the decreased aggregate values being due to the decline of prices from the previous year.

Of sheep products we sent out 1,440,197 pounds of fresh mutton, valued at $123,013, against 130,582 pounds, valued at $9,272. Of our last year's exports the United Kingdom took nearly the whole. But France and British North America for the first time appear in the list of countries purchasing our fresh mutton. This trade has all the appearance of growing rapidly. The improvement of the wool-bearing sheep of our Western plains, by judicious crosses with the best mutton breeds, is beginning to tell upon our export trade in mutton. Of wool we shipped only 60,784 pounds, valued at $17,644 against 347,854 pounds, valued at $93,358 the previous year. The immense demand of our own resuscitated wool manufacture has left but little for export, and has stimulated the import to large proportions in spite of protective tariff duties. Of wool manufactures we exported to the value of $364,377 against $448,894 the previous year. Our home demand has here also absorbed the increased product of our mills, and has narrowed the margin of goods available for export.

BREADSTUFFS.—The following table presents the distribution of our export of cereals and their preparations.

Articles.	United Kingdom.	France.	Germany.	Belgium and Netherlands.	Other European countries.
Barley:					
Bushels	176,132	....	550	....	2,624
Value	$107,416	....	$600	....	$1,206
Average per bushel	$0 60.9	....	$1 09.1	....	$0 46.0
Bread:					
Pounds	6,599	....	600	....	19,384
Value	$429	....	$59	....	$1,153
Average per pound	$0 06.5	....	$0 09.8	....	$0 06.0
Corn:					
Bushels	64,506,311	2,564,226	3,894,311	1,806,030	4,056,322
Value	$30,883,937	$1,141,239	$1,826,611	$804,565	$1,983,897
Average per bushel	$0 47.9	$0 44.5	$0 47.0	$0 44.5	$0 48.8
Corn meal:					
Barrels	4,805	30	90	6	1,408
Value	$13,523	$98	$283	$25	$3,565
Average per barrel	$2 81.2	$3 26.6	$3 14.4	$4 25.0	$2 53.2
Oats:					
Bushels	123,516	1,991,396	298	698,860	43,740
Value	$44,011	$628,919	$96	$219,248	$14,118
Average per bushel	$0 35.6	$0 31.6	$0 32.2	$0 31.4	$0 32.3
Rye:					
Bushels	135,700	167,817	748,622	3,393,689	330,084
Value	$86,604	$105,531	$455,600	$2,213,155	$205,379
Average per bushel	$0 63.8	$0 62.8	$0 60.9	$0 65.2	$0 62.2
Rye flour:					
Barrels	....	....	20	....	1
Value	....	....	$70	....	$3
Average per barrel	....	....	$3 50.0	....	$3 00.0
Wheat:					
Bushels	57,419,292	42,147,558	422,242	11,443,528	5,324,375
Value	$60,356,674	$46,691,216	$470,692	$12,157,699	$5,825,454
Average per bushel	$1 05.1	$1 10.8	$1 11.5	$1 06.2	$1 09.5
Flour:					
Barrels	2,629,665	27,075	11,233	52,097	121,795
Value	$13,964,979	$129,703	$64,628	$229,278	$540,729
Average per barrel	$5 31.1	$4 79.5	$5 75.3	$5 16.8	$4 43.9
Other grains:					
Value	$220,938	$441	$2,960	$120	$14,800
Other preparations of grain:					
Value	$1,413,364	$1,180	$23,332	$28,660	$6,374

Articles.	United Kingdom.	France.	Germany.	Belgium and Netherlands.	Other European countries.
Rice:					
Pounds	2,975	47,993	2,524	....	280
Value	$206	$3,580	$192	....	$22
Average per pound	$0 06.9	$0 07.5	$0 07.6	....	$0 07.8
Total value to each country:					
1879	$107,092,081	$48,701,907	$2,845,123	$15,692,750	$8,596,700
1878	125,819,463	7,657,563	1,764,517	9,362,071	5,671,707
Per cent. of total value to each country:					
1879	50.80	23.17	1.36	7.46	4.09
1878	69.50	4.20	0.96	5.11	3.10

Articles.	British North America.	Mexico, Central and South America.	West Indies.	Other countries.	Total.	Per cent. of each article.
Barley:						
Bushels	38,367	120,310	....	377,553	715,536	
Value	$23,591	$53,674	....	$214,693	$401,180	0.19
Average per bushel	$0 61.5	$0 44.6	....	$0 56.8	$0 56.1	
Bread:						
Pounds	137,344	4,153,726	8,790,468	2,467,069	15,565,190	
Value	$7,552	$210,577	$345,328	$117,373	$682,471	0.82
Average per pound	$0 05.5	$0 05.6	$0 04.0	$0 04.8	$0 04.4	
Corn:						
Bushels	7,297.027	364,349	1,293,790	513,886	86,296,252	
Value	$2,822,565	$232,712	$672,983	$286,581	$40,655,120	19.20
Average per bushel	$0 38.6	$0 63.8	$0 52.0	$0 55.7	$0 47.1	
Corn meal:						
Barrels	211,927	11,839	162,660	4,392	397,160	
Value	$513,220	$34,634	$473,876	$13,007	$1,052,231	0.50
Average per barrel	$2 42.2	$2,92.5	$2 91.3	$2 96.0	$2 65.0	
Oats:						
Bushels	2,219,315	22,205	241,454	111,352	3,542,136	
Value	$557,041	$9,671	$95,877	$48,763	$1,618.644	0.77
Average per bushel	$0 25.1	$0 43.5	$0 39.7	$0 43.8	$0 29.7	
Rye:						
Bushels	71,602	....	....	4,201	4,851,715	
Value	$34,832	....	....	$2,869	$3,103,970	1.49
Average per bushel	$0 47.2	....	....	$0 68.3	$0 64.0	
Rye flour:						
Barrels	331	230	3,765	4	4,351	
Value	$1,259	$794	$12,970	$17	$15,113	0.01
Average per barrel	$3 80.4	$3 45.2	$3 44.5	$4 25.0	$3 47.3	
Wheat:						
Bushels	5,204,033	226,035	20,524	146,349	122,353,936	
Value	$4,776,804	$236,149	$25,182	$161,209	$130,701,079	61.80
Average per bushel	$0 92.0	$1 04.5	$1 22.7	$1 10.2	$1 06 0	
Flour:						
Barrels	504,920	1,117,041	810,434	355,454	5,629,714	
Value	$2,292,341	$6,237,363	$4,145,2[illegible]	$1,822,564	$29,567,713	14.00
Average per barrel	$4 73.8	$5 58.0	$5 11.4	$5 13.0	$5 25.0	
Other grains:						
Value	$16,612	$122,974	$408,849	$29,842	$817,536	0.39
Other preparations of grain:						
Value	$27,151	$73,554	$87,307	$78,910	$1,740,471	0.82
Rice:						
Pounds	50,663	103,112	88,449	444,150	.740,136	
Value	$2,694	$5,882	$4,963	$17,999	$35,538	0.01
Average per pound	$0 05.3	$0 05.7	$0 05.6	$0 04.1	$0 04.8	
Total value to each country:						
1879	$11,176,492	$7,217,924	$6,273,253	$2,794,776	$210,391,066	100.00
1878	14,675,341	7,996,210	6,216,317	2,648,515	181,811,794	
Per cent. of total value to each country:						
1879	5.35	34.5	3.00	1.32	100.00	
1878	8.00	4.35	3.38	1.40	100.00	

The aggregate export value of our breadstuffs shows an increase of $28,579,272, or 15 per cent. over the previous fiscal year, notwithstanding all the items in the table present a lower average value except corn meal, which has but an insignificant effect upon the entire aggregate. The average value of barley fell off a third, corn 18 per cent., oats 10 per cent., rye 12 per cent., wheat 21 per cent., rice 8 per cent. Of grain products corn meal increased from $2.62.5 per barrel to $2.65; rye flour fell off 21 per cent., and wheat flour over 15 per cent. In quantity our barley export was less than one-fifth that of the previous year; corn increased about 1 per cent.; oats declined about 4 per cent.; rye increased 15 per cent. Our wheat export showed a vast enlargement, and to this more than to any other cause is due our immense increase in the aggregate value of our breadstuffs export. The amount sent out was 49,948,975 bushels larger than in 1878, an increase of nearly 70 per cent. This was mostly of the crop of 1878 marketed during the fiscal year 1879. Our rice export, though about one-sixth larger than last year, is still insignificant. Of preparations of grain corn meal fell off 8 per cent., and rye flour 37 per cent. Wheat flour enlarged 43 per cent.

In the distribution of this vast amount of production very considerable changes from last year are noted. The United Kingdom takes about half the total value against nearly seven-tenths the previous year. In barley the export declined from 3,421,308 bushels to 176,132; corn fell off slightly; oats increased; rye fell to about two-fifths, but wheat increased nearly 3,000,000 bushels and flour over a million barrels. France vastly increased her proportion of this general aggregate, especially in wheat, taking 42,147,558 bushels against 4,337,091 the previous year; she also enlarged her quota of oats nearly threefold. Her flour export, though largely increased, is still quite small. Her quota of corn is somewhat decreased. The raw grain export to Germany is largely augmented excepting oats, which almost disappeared. Belgium and Netherlands have also increased their demand on us for grain, especially wheat, which enlarged from 4,337,091 bushels to 11,443,528; their flour quota increased about 50 per cent. Our trade in breadstuffs to other European countries has also increased; all the grains were taken in increased quantities, but the export of flour fell off. With British North America our aggregate values have fallen off over $3,000,000. The barley export is but a little over 10 per cent. of the previous one in quantity. Corn, oats, rye, and wheat have declined more or less, but the number of barrels of flour greatly increased. With that portion of the American continent south of us and with the West Indies the aggregate values have somewhat increased, but bear a smaller proportion to the whole than last year. The same may be said of the other countries of the world not included in the above.

COTTON AND COTTON MANUFACTURES.—The distribution of our exports of cotton and its manufactures may be found in the following table:

Articles.	United Kingdom.	France.	Germany.	Belgium and Netherlands.	Other European countries.
Sea island:					
Bales	9, 228	2, 233	....	....	....
Pounds	3, 229, 837	800, 391	....	....	....
Value	$882, 154	$225, 918	....	....	....
Average per pound	$0 27. 2	$0 28. 1	....	....	....
Other raw:					
Bales	2, 080, 533	416, 238	291, 823	76, 004	548, 085
Pounds	980, 544, 671	196, 187, 714	137, 484, 413	35, 430, 925	256, 645, 844
Value	$97, 821, 681	$18, 848, 459	$13, 110, 159	$3, 490, 774	$26, 173, 910
Average per pound	$0 09. 9	$0 09. 6	$0 09. 5	$0 09. 9	$0 10. 2
Colored goods:					
Yards	8, 851, 512	....	43, 497	52, 728	10, 430
Value	$701, 073	....	$3, 470	$4, 941	$880
Average per yard	$0 07. 9	....	$0 08. 0	$0 09. 3	$0 08. 4
Uncolored goods:					
Yards	22, 567, 249	20, 000	1, 661, 103	114, 482	89, 102
Value	$1, 683, 992	$900	$131, 314	$9, 494	$9, 804
Average per yard	$0 07. 4	$0 04. 5	$0 08. 0	$0 08. 3	$0 11. 0
Other manufactures:					
Value	$329, 246	$807	$56, 879	$3, 357	$3, 311
Total value to each country:					
1879	$101, 418, 146	$19, 076, 084	$13, 301, 822	$3, 508, 566	$26, 187, 905
1878	119, 003, 985	25, 964, 236	13, 455, 953	4, 625, 502	17, 559, 134
Per cent. of aggregate value to each country:					
1879	58. 57	11. 02	7. 68	2. 02	15. 13
1878	61. 86	13. 45	7. 03	2. 39	9. 08
Raw material in 1879:					
Value	$98, 703, 835	$19, 074, 377	$13, 110, 159	$3, 490, 774	$26, 173, 910
Manufactures in 1879:					
Value	$2, 714, 311	$1, 707	$191, 663	$17, 792	$13, 995
Per cent	2. 68	0. 01	1. 52	0. 51	0. 05
Manufactures in 1878:					
Per cent	1. 32	0. 03	1. 61	0. 78	....

Articles.	British North America.	Mexico, Central and South America.	West Indies.	Other countries.	Total.	Per cent. of each product.
Sea island:						
Bales	....	....	....	....	11, 461	
Pounds	....	....	....	....	4, 030, 228	0. 64
Value	....	....	....	....	$1, 108, 072	
Average per pound	....	....	....	....	$0 27. 5	
Other raw:						
Bales	15, 975	21, 932	690	....	3, 451, 280	
Pounds	7, 740, 308	9, 997, 442	311, 283	....	1, 624, 342, 605	93. 09
Value	$788, 450	$925, 463	$37, 283	....	$161, 196, 178	
Average per pound	$0 10. 2	$0 09. 3	$0 11. 9	....	$0 09. 9	
Colored goods:						
Yards	1, 028, 846	22, 419, 088	6, 258, 805	6, 457, 152	45, 116, 058	
Value	$75, 109	$1, 504, 896	$463, 485	$455, 431	$3, 209, 285	1. 70
Average per yard	$0 07. 3	$0 06. 7	$0 07. 4	$0 07. 1	$0 07. 1	
Uncolored goods:						
Yards	3, 855, 557	17, 082, 168	4, 359, 341	34, 331, 317	84, 081, 319	
Value	$360, 271	$1, 299, 754	$415, 557	$2, 377, 045	$6, 288, 131	3. 30
Average per yard	$0 09. 3	$0 07. 6	$0 09. 5	$0 06. 9	$0 07. 5	
Other manufactures:						
Value	$557, 184	$193, 611	$54, 129	$158, 010	$1, 356, 534	1. 27
Total value to each country:						
1879	$1, 781, 014	$3, 923, 724	$970, 453	$2, 990, 486	$173, 158, 200	100. 00
1878	2, 037, 073	3, 939, 306	813, 922	4, 071, 033	191, 470, 144	

Cotton and cotton manufactures—Continued.

Articles.	British North America.	Mexico, Central and South America.	West Indies.	Other countries.	Total.	Per cent. of each product.
Per cent. of aggregate value to each country:						
1879	1.03	2.26	0.56	0.73	100.00	
1878	1.63	2.02	0.42	2.12	100.00	
Raw material in 1879:						
Value	$788,450	$925,463	$37,282	....	$162,204,250	
Manufactures in 1879:						
Value	$992,564	$2,993,261	$933,171	$2,990,486	$10,853,950	
Per cent	55.76	76.29	96.18	100.00	5.98	
Manufactures in 1878:						
Per cent	60.78	90.93	100.00	100.00	5.97	

The total value of our cotton exports fell off $18,311,944 or 10 per cent. from the previous aggregate. In raw material there was a falling off of one-third in the high priced sea island cotton, which averaged $0,27.5 per pound against $0,25.5 last year. Of other raw cotton there was an increase in quantity of 27,164,469 pounds, or about 1½ per cent. Its average value was $0,09.9 per pound against $0,11.1 the previous year. It should be remembered that it represented the crop grown and gathered in 1878, and could have embraced little, if any, of the crop of 1879. The whole of our sea island export, as in the previous year, went to the United Kingdom and France. Of other raw cotton the United Kingdom, France, Belgium, and Netherlands decreased their quota, while Germany and other European countries made an increased demand. The European continent took 16,614,710 pounds more in the fiscal year of 1879 than in that of 1878; that is, so many pounds more of the crop of 1878 than of that of 1877. To other countries of the world our aggregate export somewhat increased.

Our cotton goods fell in value from $11,438,660 in 1878 to $10,853,950 in 1879. There was an increase in the export of colored goods of 7,350,745 yards, or nearly 20 per cent. But uncolored fabrics fell off 4,446,873 yards, or 5 per cent. The average values per yard for both colored and uncolored goods remain nearly the same. Miscellaneous cotton manufactures suffer some decline in aggregate value. Of colored goods the United Kingdom takes about double her previous quantity; France takes none at all. Germany and the rest of Europe take a smaller quantity. British North America declines. But the American continent south of us, together with the West Indies, increase their demand, as do the other countries of the world. For uncolored goods the United Kingdom and Europe generally have about doubled their demand. British North America has also increased, but all the other countries of the world have fallen off. The proportion of the values of manufactures to the total cotton export is about the same as last year, a little below 6 per cent.

WOOD AND ITS PRODUCTS.—This branch of our agricultural export shows a decline of $1,624,150, or over four millions in two years. The greatest loss is in timber, sawed and hewed, in which there is a falling off of 5,105,674 cubic feet. Laths, hogsheads, barrels, miscellaneous lumber, fire-wood, telegraph-poles, logs, masts, spars, pot and pearl ashes, tanning-bark, tar and pitch, show increased values at lower prices. All the other items decline. The United Kingdom takes to the value of $3,120,727 against $6,796,104 in 1878, and $9,220,006 in 1877; France,

$656,663 against $758,282 last year; Germany, $838,427 against $1,297,470; British America, $1,375,706 against $2,344,054. With other countries our trade shows some enlargement.

MISCELLANEOUS.—The leading miscellaneous articles of agricultural export show a considerable increase in aggregate value as well as in quantities. The average prices have fallen in all the items except cotton-seed, hops, oil-cake, and ginseng. The leaf-tobacco export, which is full half of the whole aggregate value, increased in quantity 13 per cent. The following table shows the distribution of this class of products:

Articles.	United Kingdom.	France.	Germany.	Belgium and Netherlands.	Other countries of Europe.
Fruits:					
Value	$993,288	$29,938	$166,741	$119,486	$10,944
Hemp and products:					
Value	$661,927	$180,716	$41,920	$107,902	$69,953
Hops:					
Pounds	5,156,818	....	3,523	6,523	....
Value	$666,993	....	$458	$950	....
Average per pound	$0 13.0	....	$0 12.9	$0 14.6	....
Spirits:					
Gallons	108,529	3,380,162	122,476	9,777	2,544,187
Value	$45,842	$1,018,566	$35,943	$3,600	$828,497
Average per gallon	$0 42.2	$0 30.1	$0 29.3	$0 36.8	$0 32.6
Oil-cake:					
Pounds	322,681,409	16,765	389,494	10,395	....
Value	$4,248,323	$169	$6,323	$140	....
Average per pound	$0 12.8	$0 10.1	$0 16.2	$0 13.5	....
Oil, cotton-seed:					
Gallons	557,785	1,259,878	1,094	99,396	3,348,089
Value	$230,117	$538,251	$451	$44,467	$1,383,083
Average per gallon	$0 41.3	$0 42.7	$0 41.3	$0 44.7	$0 41.3
Seed, cotton:					
Pounds	16,397,938	....	....	....	....
Value	$141,188	....	....	....	....
Average per pound	$0 08.7	....	....	....	....
Starch:					
Pounds	2,974,377	98,745	3,546,214	4,453,760	78,696
Value	$133,953	$3,988	$152,761	$179,060	$3,841
Average per pound	$0 04.5	$0 04.0	$0 04.3	$0 04.0	$0 04.9
Sugar, refined:					
Pounds	40,997,632	85	141,237	....	57,051
Value	$3,437,188	$7	$12,680	....	$4,834
Average per pound	$0 08.4	$0 08.2	$0 09.0	....	$0 08.5
Molasses:					
Gallons	3,794,760	35	735,972	1,318	53,318
Value	$664,396	$11	$200,614	$343	$17,125
Average per gallon	$0 17.5	$0 31.4	$0 27.3	$0 25.9	$0 32.1
Tobacco, leaf:					
Pounds	65,010,286	44,784,776	112,998,952	38,214,957	43,487,729
Value	$7,151,868	$2,572,908	$8,108,819	$2,220,555	$3,030,595
Average per pound	$0 11.0	$0 06.0	$0 07.2	$0 05.8	$0 06.9
Tobacco, manufactures:					
Value	$989,155	$2,526	$82,997	$95,378	$194,302
Potatoes:					
Bushels	248	241	....	....	....
Value	$194	$243	....	....	....
Average per bushel	$0 78.0	$1 01.0	....	....	....
Ginseng:					
Pounds	24,948	....	....	....	....
Value	$31,124	....	....	....	....
Average per pound	$1 24	....	....	....	....
Total value to each country:					
1879	$19,395,556	$4,347,323	$8,809,706	$2,771,831	$3,548,274
1878	19,588,776	3,360,726	6,329,832	2,281,552	6,146,137
Per cent. of value to each country:					
1878	40.10	9.00	18.50	5.70	7.30
1879	40.18	6.90	12.99	4.63	12.64

Articles.	British North America.	Mexico, Central and South America.	West Indies.	Other countries.	Total of each product.	Per cent. of each product.
Fruits:						
Value	$392, 962	$77, 266	$65, 830	$149, 927	$1, 916, 382	4. 00
Hemp and products:						
Value	$93, 085	$74, 710	$47, 515	$54, 077	$1, 331, 805	2. 60
Hops:						
Pounds	14, 260	42, 839	2, 438	231, 758	5, 458, 159	
Value	$966	$5, 163	$336	$26, 230	$701, 095	1. 30
Average per pound	$0 06. 8	$0 12. 0	$0 13. 7	$0 11. 3	$0 12. 8	
Spirits:						
Gallons	15, 070	765, 591	7, 802	1, 348, 063	8, 311, 657	
Value	$19, 672	$251, 159	$2, 743	$467, 219	$2, 673, 241	5. 30
Average per gallon	1. 30	$0 32. 8	$0 35. 2	$0 34. 6	$0 32. 2	
Oil-cake:						
Pounds	42, 880	71, 554	7, 614, 965	167, 933	340, 995, 395	
Value	$651	$1, 241	$134, 373	$2, 790	$4, 394, 010	8. 70
Average per pound	$0 15. 2	$0 17. 3	$0 17. 5	$0 16. 7	$0 12. 9	
Oil, cotton-seed:						
Gallons	....	759	14, 378	70, 791	5, 352, 530	
Value	....	$454	$4, 171	$31, 886	$2, 232, 880	4. 40
Average per gallon	....	$0 59. 8	$0 29. 0	$0 45. 0	$0 41. 7	
Seed, cotton:						
Pounds	....	....	....	....	16, 397, 938	
Value	....	....	....	....	$141, 188	0. 30
Average per pound	....	....	....	....	$0 08. 7	
Starch:						
Pounds	91, 864	2, 596, 720	310, 341	147, 937	14, 298, 654	
Value	$6, 072	$95, 722	$15, 520	$10, 880	$601, 797	1. 20
Average per pound	$0 06. 6	$0 03. 9	$0 05. 0	$0 07. 3	$0 04. 2	
Sugar, refined:						
Pounds	17, 389, 705	10, 677, 781	1, 957, 232	1, 088, 286	72, 309, 009	
Value	$1, 520, 943	$954, 039	$175, 241	$99, 092	$6, 164, 024	12. 10
Average per pound	$0 08. 7	$0 08. 5	$0 08. 9	$0 09. 1	$0 08. 5	
Molasses:						
Gallons	19, 965	7, 224	104, 476	11, 299	4, 727, 367	
Value	$8, 560	$2, 138	$21, 065	$4, 921	$919, 173	2. 00
Average per gallon	$0 42. 9	$0 29. 6	$0 20. 2	$0 43. 6	$0 19. 4	
Tobacco, leaf:						
Pounds	8, 172, 801	3, 914, 124	2, 044, 468	4, 551, 447	322, 279, 540	
Value	$1, 039, 187	$421, 546	$194, 931	$416, 805	$25, 157, 364	50. 00
Average per pound	$0 12. 7	$0 10. 8	$0 09. 5	$0 09. 2	$0 07. 8	
Tobacco, manufactures:						
Value	$65, 693	$179, 104	$280, 416	$1,168,305	$3, 057, 876	6. 10
Potatoes:						
Bushels	20, 623	42, 569	527, 209	34, 812	625, 342	
Value	$11, 931	$36, 780	$466, 081	$29, 880	$545, 109	1. 00
Average per bushel	$0 58. 0	$0 86. 3	$0 88. 4	$0 85. 8	$0 55. 2	
Ginseng:						
Pounds	....	....	....	366, 316	391, 264	
Value	....	....	....	$434, 487	$465, 611	1. 10
Average per pound	....	....	....	$1 19. 0	$1 19. 0	
Total value to each country:						
1879	$3, 069, 722	$2, 059, 322	$1, 408, 272	$2, 896, 499	$50, 301, 555	100. 00
1878	2, 738, 039	2, 449, 507	1, 678, 281	4,151,205	48, 694, 055	
Per cent. of value to each country:						
1878	6. 20	4. 20	3. 00	6. 00	100. 00	
1879	5. 60	5. 03	3. 42	8. 56	100. 00	

The export to the United Kingdom about maintains its former proportion; that of France, Germany, Holland, and Belgium has increased, while the rest of Europe declines. British North America has slightly increased its ratio, while all other countries of the world have fallen off. The United Kingdom takes nearly all our hops and oil-cake, and all our cotton-seed. France takes nearly half our export of alcoholic spirits, using it largely to qualify her wines. Germany takes the largest proportion of our leaf-tobacco and starch. Most of our ginseng is sent to Hong-Kong where it is sold to the Chinese in the interior. There is a decline in this export, as the stock of this raw material in the country is running short.

MARKET PRICES OF FARM

The following quotations represent as nearly as practicable

Products.	January.	February.	March.	April.	May.
NEW YORK.					
Flour:					
Superfine State and Western........bbl.	$3 10 to $3 50	$3 10 to $3 50	$3 30 to $3 75	$3 30 to $3 60	$3 20 to $3 65
Extra State........do..	3 75 to 3 85	3 65 to 3 85	3 85 to 4 00	3 80 to 3 90	3 70 to 3 80
Extra to choice Western..............bbl.	3 70 to 7 75	3 60 to 8 25	3 80 to 8 50	3 70 to 8 25	3 65 to 8 00
Common to fair Southern extras.......bbl.	3 75 to 4 60	3 65 to 4 85	3 85 to 5 00	3 85 to 5 15	3 80 to 4 65
Good to choice Southern..............bbl.	4 75 to 5 75	4 75 to 6 00	4 85 to 6 25	4 75 to 6 25	4 75 to 6 00
Wheat:					
No. 2 spring...... bush.	96 to 98	99 to 1 01	1 05 to 1 08	1 03 to 1 05	1 01 to 1 03
Red winter.........do..	1 08½ to 1 08¾	1 09¼	1 13 to 1 13½	1 15¼ to 1 15½	1 14½ to 1 15
Amber..............do..	1 02 to 1 09	1 05 to 1 09½	1 08 to 1 13½	....	....
White..............do..	1 04 to 1 11	1 05 to 1 11	1 07 to 1 13½	1 08 to 1 14	1 08 to 1 13
Corn...............do..	44 to 49	44 to 50	44 to 52	45 to 47	42 to 48
Oats...............do..	29 to 36	29 to 35	32 to 38	30 to 36½	32 to 38
Rye................do..	56 to 60	56 to 60	58 to 63	58 to 62½	56 to 61½
Barley.............do..	78 to 1 00	75 to 92	67 to 85	55 to 80	....
Hay:					
Baled, 1st quality..ton.	14 00 to 16 00	14 00 to 16 00	14 00 to 15 00	14 00 to 15 00	14 00 to 16 00
Baled, 2d quality...do..	12 00 to 13 00	11 00 to 13 00	10 00 to 13 00	10 00 to 13 00	10 00 to 12 00
Beef:					
Mess...............bbl.	9 00 to 11 00	9 00 to 11 00	9 00 to 10 50	9 00 to 10 50	9 50 to 10 50
Extra mess.........do..	10 00 to 12 00	10 00 to 11 50	10 00 to 11 00	10 00 to 11 00	10 50 to 11 50
Pork:					
Mess...............bbl.	7 10 to 8 50	8 00 to 10 50	9 75 to 11 00	9 40 to 10 75	9 00 to 10 35
Extra prime........do..	7 25 to 8 00	8 25 to 8 75	9 00 to 9 50	8 50 to 9 25	8 50 to 8 75
Prime mess.........do..	9 00 to 10 00	9 50 to 10 50	10 50 to 11 00	9 75 to 10 50	9 75 to 10 00
Lard...............cental.	5 70 to 6 35	6 20 to 7 15	6 35 to 7 45	6 30 to 7 00	6 10 to 6 75
Butter:					
Western............lb.	8 to 30	8 to 32	8 to 28	8 to 28	8 to 19
State..............do..	10 to 28	10 to 28	10 to 26	10 to 25	8 to 17
Cheese:					
State factory...... lb.	5 to 9	5 to 9½	5 to 9½	5 to 9	5 to 7½
Western factory...do..	2 to 9	2 to 9	2 to 9	2 to 9	2 to 7½
Sugar, fair to prime refining..............lb.	6⅝ to 6⅞	6½ to 6¾	6⅜ to 6⅝	6⅛ to 6⅜	6 3/16 to 6⅜
Cotton:					
Ordinary to good ordinary..............lb.	7 9/16 to 8⅝	7⅝ to 8 11/16	7 15/16 to 9	9 7/16 to 10 7/16	9 15/16 to 10 15/16
Low middling to good middling..........lb.	9 1/16 to 9 15/16	9⅛ to 10	9 7/16 to 10 5/16	10 13/16 to 11⅝	11 5/16 to 12⅛
Tobacco:					
Lugs...............lb.	2½ to 4½	2½ to 4½	2½ to 4½	2½ to 4½	2½ to 4½
Leaf, low to medium.............lb.	4½ to 8	4½ to 8	4½ to 8	4½ to 8	4½ to 8
Wool:					
American XXX and picklock..........lb.	37 to 40	36 to 38	36 to 38	34 to 36	34 to 36
American X and XX.do.	30 to 36	28 to 35	28 to 35	28 to 35	28 to 33
American combing .do.	38 to 48	34 to 40	34 to 40	33 to 38	33 to 38
Pulled.............do.	17 to 35	17 to 36	17 to 36	17 to 34	17 to 34
California sp'ing clip.do.	12 to 25	12 to 25	12 to 25	13 to 24	13 to 24
California fall clip ..do.	10 to 20	10 to 20	10 to 20	9 to 17	9 to 17
CINCINNATI.					
Flour:					
Superfine..........bbl.	2 25 to 3 00	2 25 to 3 25	3 00 to 3 45	2 50 to 3 66	2 75 to 3 75
Extra..............do..	3 50 to 3 85	3 75 to 4 00	4 00 to 4 30	4 00 to 4 25	4 00 to 4 35
Family and fancy..do..	4 15 to 5 25	4 25 to 5 25	4 45 to 5 50	4 50 to 5 50	4 50 to 5 75
Wheat:					
Winter red ......bush.	92 to 95	92 to 95	1 03 to 1 04	1 00 to 1 05	1 05 to 1 06
Amber..............do..	92 to 95	92 to 95	1 03 to 1 04	1 00 to 1 05	1 02 to 1 03
White..............do..	1 00	96 to 98	1 03 to 1 05	1 03½ to 1 06	1 06½
Corn...............do..	32 to 33	32 to 32½	32 to 34	36 to 37	38 to 39
Rye................do..	50 to 52	51 to 52	53 to 55	56 to 57	56 to 57
Barley.............do..	60 to 1 10	50 to 1 00	50 to 97	75 to 1 03	90 to 95
Oats...............do..	24 to 26	24 to 26	26 to 30	27½ to 32	28½ to 32
Hay:					
Baled, No. 1.......ton.	8 50 to 9 50	9 00 to 10 10	8 50 to 9 50	9 00 to 10 00	11 00 to 12 00
Lower grades.......do..	7 00 to 8 00	7 50 to 8 50	7 00 to 8 00	7 50 to 8 50	9 00 to 10 00
Pork...............bbl.	7 80 to 7 90	9 50 to 9 75	10 00 to 10 25	10 00 to 10 50	10 00
Lard...............cental.	5 40 to 5 87	6 35 to 6 37½	6 50	6 30 to 6 50	5 95 to 6 06½
Butter:					
Choice.............lb.	14 to 31	15	17 to 18	17 to 30	11 to 20
Prime..............do..	9 to 13	10 to 15	10 to 16	14 to 15	....
Cheese, prime to choice factory............lb.	7½ to 8	7 to 7½	6¾ to 7¼	6½ to 7¼	6 to 7

PRODUCTS FOR 1879.

the state of the market at the beginning of each month.

June.	July.	August.	September.	October.	November.	December.
$3 30 to $3 80	$3 50 to $3 90	$4 00 to $4 50	$3 65 to $4 00	$4 90 to $5 30	$5 00 to $5 40	$4 90 to $5 30
3 75 to 3 85	4 05 to 4 25	4 55 to 4 70	4 30 to 4 40	5 40 to 5 50	5 60 to 5 75	5 60 to 5 75
3 65 to 7 75	4 00 to 7 50	4 50 to 8 00	4 25 to 7 25	5 35 to 7 75	5 50 to 7 25	5 50 to 7 00
3 75 to 4 85	4 15 to 5 25	4 00 to 5 60	4 35 to 5 25	5 50 to 5 90	6 00 to 6 40	5 85 to 6 25
5 00 to 6 25	5 25 to 6 00	5 70 to 6 50	5 25 to 6 00	6 00 to 6 75	6 75 to 7 75	6 40 to 7 25
1 04 to 1 05	1 05 to 1 07	1 05 to 1 06	1 02 to 1 04	1 22 to 1 23	1 31 to 1 33	1 35 to 1 38
1 15½ to 1 16	1 17½ to 1 18	1 10¼ to 1 10½	1 10 to 1 10¼	1 29 to 1 30	1 41 to 1 42	1 46½ to 1 47
....	....	....	1 04 to 1 11	1 22 to 1 29	1 35 to 1 41	1 38 to 1 46
1 10 to 1 15½	1 12 to 1 16	1 08 to 1 14	1 06 to 1 11½	1 23 to 1 31	1 40 to 1 41	1 40 to 1 46
41 to 54	41 to 52	43 to 53	45 to 57½	53 to 60	58 to 67	58 to 66
33 to 42	36 to 43	33 to 41	29 to 38	35 to 40½	39 to 44	44 to 49
60 to 62	59 to 61	63 to 69	64 to 68	76 to 80	87 to 89	89 to 91
....	....	....	....	70 to 90	70 to 98	75 to 1 05
15 00 to 17 00	14 00 to 16 00	14 00 to 17 00	14 00 to 16 00	14 00 to 16 00	14 00 to 18 00	14 00 to 19 00
11 00 to 13 00	11 00 to 13 00	10 00 to 13 00	10 00 to 12 00	10 00 to 12 00	10 00 to 12 00	12 00 to 13 00
9 50 to 10 50	9 00 to 10 00	9 00 to 10 00	....	9 00 to 10 00	....	12 00 to 12 75
10 50 to 11 50	11 00 to 11 50	11 00 to 12 00	11 00 to 12 00	11 50 to 13 00	11 25 to 12 00	12 50 to 13 50
9 00 to 10 12½	9 50 to 10 25	8 85 to 9 10	8 70 to 9 15	9 40 to 9 80	10 00 to 10 40	12 00 to 12 30
8 50 to 8 75	9 00 to 9 12½	8 50 to 8 60	8 50	8 50 to 9 00	8 00 to 9 00	9 50 to 10 00
9 75 to 10 00	10 00	....	....	9 50	9 50 to 10 00	11 00 to 12 00
6 15 to 6 75	6 10 to 6 75	5 85 to 6 50	5 20 to 6 07½	6 15 to 6 80	6 50 to 6 75	7 70 to 8 20
7 to 18	7 to 16	7 to 16½	7 to 18½	11 to 28	14 to 31	15 to 38
8 to 18	8 to 16	8 to 17	8 to 18¼	14 to 29	16 to 33	20 to 38
2 to 8	1 to 6	2 to 6	2 to 5⅜	6 to 11	10½ to 13	9½ to 13¼
1 to 7	1 to 6	2 to 5½	2 to 5	11 to 14	11 to 13	8 to 13
6 5/16 to 6 7/16	6⅜ to 6½	6⅝ to 6⅞	6 11/16 to 6¾	6⅞ to 7⅛	8 to 8½	8⅞ to 9⅛
11 13/16 to 12 11/16	11 to 11⅞	10 1/16 to 10 15/16	10 11/16 to 11 9/16	9 1/16 to 9 15/16	9⅞ to 10¾	11 1/16 to 11 15/16
12 15/16 to 13 11/16	12⅜ to 12⅞	11 3/16 to 11 15/16	11 3/16 to 12 9/16	10 13/16 to 10⅞	11 to 11 11/16	12 3/16 to 12⅞
2½ to 5	3 to 4½	3½ to 6	3½ to 6	3½ to 6	3½ to 6	2½ to 6
4½ to 8	4½ to 7½	5½ to 8½	5½ to 8½	5½ to 8½	5½ to 8½	5 to 8
38 to 40	43 to 45	42 to 45	40 to 42	40 to 43	....	50 to 55
32 to 38	31 to 42	32 to 40	32 to 39	33 to 40	43 to 44	42 to 53
36 to 43	Nominal.	35 to 40	37 to 44	38 to 45	....	46 to 57½
20 to 38	20 to 40	18 to 40	18 to 40	22 to 44	....	25 to 55
13 to 32	15 to 32	15 to 30	15 to 30	15 to 32	....	18 to 36
9 to 20	9 to 20	9 to 22	....	....	20 to 27½	18 to 37
2 85 to 4 25	2 50 to 3 75	2 50 to 3 50	2 50 to 3 35	4 00 to 4 35	4 85 to 5 10	5 00 to 5 25
4 65 to 4 90	4 50 to 4 75	4 00 to 4 35	4 00 to 4 25	4 70 to 4 95	5 35 to 5 60	5 50 to 5 75
5 10 to 6 00	4 90 to 6 00	4 50 to 5 75	4 50 to 5 75	5 15 to 6 50	5 80 to 6 85	6 00 to 7 00
1 09 to 1 10	1 05 to 1 10	92 to 95	94 to 95	1 11 to 1 13	1 20 to 1 23	1 28 to 1 33
1 08 to 1 09	1 02	92 to 95	93 to 94	1 11 to 1 13	1 20 to 1 22	1 28 to 1 30
....	95 to 1 02	94 to 97	97	1 11 to 1 13	1 24	1 31 to 1 33
38 to 39½	37½ to 43	38½ to 44	39 to 45	41 to 45	46 to 47	40 to 43½
57 to 57½	56 to 57	54 to 55	53 to 54½	64 to 69	80	85 to 87
65 to 1 05	60 to 85	75 to 90	80 to 95	80 to 92	65 to 95	64 to 95
32 to 35	34 to 36	27 to 35	28 to 31	30 to 32	34 to 36	36 to 38
12 50 to 13 50	13 00 to 13 50	14 00 to 16 00	14 00 to 15 00	14 00 to 14 50	14 00 to 15 50	16 00 to 17 00
10 50 to 12 00	11 00 to 12 50	12 00 to 13 50	12 00 to 13 50	12 00 to 13 00	12 00 to 14 00	13 00 to 15 00
10 00	10 00 to 10 50	8 75 to 9 00	8 00 to 8 50	9 00 to 9 25	11 50	12 50 to 13 50
6 02½ to 6 10	6 00	5 50 to 5 75	5 50 to 5 55	6 00 to 6 50	6 25 to 6 50	7 50 to 7 55
12 to 20	12 to 18	13 to 20	13 to 20	18 to 20	23 to 32	23 to 25
9½ to 11	9 to 10	11 to 12	9 to 12	12 to 17	18 to 22	20 to 22
7 to 7½	6 to 6½	5½ to 6	6 to 6½	11 to 11½	12 to 13½	12 to 13½

MARKET PRICES OF FARM

Product.	January.	February.	March.	April.	May.
CINCINNATI—Cont'd.					
Sugar:					
New Orleans, fair to good ....lb.	$0 5½ to $0 5¾	$0 5¾ to $0 6	$0 6 to $0 6¼	$0 6½ to $0 6½	$0 6⅜ to $0 6½
Prime ....do..	6 to 6¼	6¼ to 6½	6½ to 6¾	6¾ to 7	6⅝ to 6¾
Peanuts ....do..	3¾ to 4¾	3¼ to 4½	3¾ to 4⅝	3¾ to 4¾	4½ to 5¼
Cotton:					
Ordinary to good ordinary ....lb.	7¼ to 8	7½ to 8	8 to 8½	8¾ to 9¼	10¼ to 10¾
Low middling to good middling..........lb.	8½ to 9⅛	8½ to 9½	8¾ to 9⅝	9¾ to 10⅜	11⅛ to 11¾
Wool:					
Fleece-washed ......lb.	28 to 32	28 to 32	28 to 32	28 to 30	25 to 28
Tub-washed.......do..	25 to 33	25 to 33	24 to 32	20 to 31	20 to 30
Unwashed cloth'g.do..	16 to 21	16 to 21	16 to 21	16 to 21	16 to 20
Unwashed comb'g.do..	23 to 25	23 to 25	22 to 24	22 to 24	22 to 23
Pulled ....do..	25 to 26	25 to 26	25 to 26	25 to 26	24 to 25
CHICAGO.					
Flour:					
Choice winter ex ..bbl.	4 50 to 5 00	4 75 to 5 12½	4 25 to 5 50	4 25 to 5 50	4 25 to 5 50
Fair to good extra..do..	3 50 to 4 25	3 50 to 4 00	3 50 to 4 25	3 75 to 4 25	3 75 to 4 25
Choice spring ex...do..	4 50 to 5 00	4 50 to 5 25	4 50 to 5 00	4 50 to 5 00	4 50 to 4 75
Common to good ex.do..	3 50 to 4 50	3 25 to 4 25	3 50 to 6 00	3 50 to 6 00	3 50 to 4 50
Patent spring......do..	6 00 to 7 50	6 00 to 7 50	6 00 to 8 00	6 00 to 8 00	6 00 to 8 00
Spring superfines..do..	2 00 to 3 00	2 00 to 3 00	2 50 to 3 25	2 50 to 3 25	2 50 to 3 00
Wheat:					
No. 1, spring .....bush.	....	....	....	....	90½
No. 2, spring.......do..	82⅛ to 82⅞	85¼ to 85⅝	94⅛ to 94⅝	89¾ to 92¾	88¾ to 89
No. 3, spring.......do..	69½ to 70	70½ to 71	81½ to 82	80	77 to 77½
Rye, No. 2 ....do..	40 to 45½	41½ to 44	46½ to 49	48½ to 49	48 to 50
Barley, No. 2 ....do..	94 to 94½	84 to 85	80	70	67
Corn, No. 2 ....do..	29⅞ to 30⅛	30⅞ to 31	33 to 34	34½ to 35½	30¾ to 33¼
Oats, No. 2..........do..	20¾ to 21	19 to 20	23 to 23⅛	25 to 30	23½ to 30
Hay:					
Timothy ....ton.	7 00 to 8 25	7 00 to 8 50	7 00 to 8 50	7 00 to 8 50	7 50 to 9 50
Prairie ....do..	6 50 to 7 75	7 00 to 7 25	7 00 to 7 25	6 50 to 7 50	6 00 to 7 00
Beef:					
Mess ....bbl.	7 75 to 8 00	8 00 to 8 25	8 25 to 8 50	8 75 to 9 00	9 00 to 9 25
Extra mess........do..	8 50 to 8 75	8 75 to 9 00	9 00 to 9 25	9 75 to 10 00	10 00 to 10 25
Hams ....do..	13 50 to 14 00	15 75 to 16 00	17 75 to 18 00	16 50 to 17 50	16 50 to 17 50
Pork:					
Mess ....bbl	6 00 to 7 55	8 00 to 8 50	8 37½ to 10 10	8 40 to 10 32	8 00 to 9 55
Prime mess ....do..	6 50 to 6 75	....	9 00 to 9 25	9 25 to 9 50	8 75 to 9 00
Extra prime.......do..	6 00	7 25 to 7 50	8 50 to 8 75	8 25 to 8 50	7 75 to 8 00
Lard..............cental.	5 37 to 5 50	6 32½ to 6 35	6 70	6 35 to 6 37½	6 05 to 6 07½
Butter:					
Choice to fancy.....lb.	22 to 27	24 to 29	22 to 26	21 to 25	13 to 20
Medium to good....do..	11 to 20	12 to 24	12 to 21	12 to 21	9 to 17
Cheese:					
Good to choice factory ....lb.	7¾ to 8¼	8 to 8½	8 to 8⅜	8½ to 8¾	8 to 8½
Poor to fair factory.do..	2 to 7	2 to 7	2 to 7	2 to 7½	2 to 6¾
Sugar, New Orleans, common to choice.......lb.	5⅞ to 7⅝	6¼ to 7½	6¼ to 7½	6½ to 7½	6⅜ to 7⅜
Wool:					
Unwashed ....lb.	15 to 23	16 to 23	16 to 23	16 to 23	16 to 20
Fleece-washed.....do..	28 to 31	28 to 32	28 to 32	28 to 32	27 to 30
Tub-washed.......do..	30 to 38	30 to 38	30 to 38	30 to 37	30 to 38
Colorado ....do..	15 to 25	13 to 24	13 to 24	13 to 24	13 to 24
SAINT LOUIS.					
Flour:					
Superfine..........bbl.	2 90 to 3 10	3 00 to 3 15	3 25 to 3 40	3 55 to 3 70	3 60 to 3 75
Extra ....do..	3 20 to 4 00	3 35 to 4 15	3 60 to 4 45	4 00 to 4 70	3 95 to 4 80
Family and fancy..do..	4 20 to 5 00	4 35 to 5 25	4 70 to 5 40	4 75 to 5 50	4 90 to 5 50
Wheat:					
White winter... bush..	89 to 92	88 to 1 00	90 to 1 06	1 00 to 1 06	1 03 to 1 07
Red winter ....do..	78 to 93	92 to 98	1 00 to 1 03	99½ to 1 02⅝	1 01½ to 1 07
Spring ....do..	68 to 76	....	....	....	....
Corn ....do..	29 to 29¾	32 to 33½	33⅝ to 35	32½ to 35	32⅞ to 36
Rye ....do..	42⅛ to 42½	41½ to 43¾	45 to 48	45 to 48	48 to 49½
Barley..............do..	45	65 to 75	65	85	65
Oats................do..	20½ to 21¼	24½ to 24¾	26	26 to 27	26¼ to 26½
Hay:					
Timothy..........ton..	7 00 to 9 00	7 75 to 10 00	8 00 to 10 50	8 50 to 12 00	10 00 to 12 50
Prairie ....do..	....	....	....	....	....
Beef:					
Mess ....bbl.	....	....	....	....	....

PRODUCTS FOR 1879—Continued.

June.	July.	August.	September.	October.	November.	December.
$0 6½	$0 6½	$0 6¾	$0 7	$0 7	....	$0 8 to $0 8⅓
6¾	6¾	6½	7¼	7¼	....	8¼ to 8½
$4¾ to 5½	$0 5 to 5½	$0 5¼ to 6¼	$0 5½ to 6½	$0 5⅝ to 6½	$0 5¼ to $0 6¼	3½ to 4¾
12 to 12⅓	11⅓ to 11⅝	9⅞ to 10⅜	10⅝ to 11⅛	8⅞ to 9¼	9⅝ to 10¼	10⅜ to 71⅛
12¾ to 13¼	11⅞ to 12⅜	10⅝ to 11⅛	11⅓ to 12⅛	9⅝ to 10¼	10⅝ to 11⅛	11½ to 12⅛
28 to 32	33 to 36	31 to 36	32 to 37	32 to 36	35 to 40	41 to 45
26 to 34	26 to 37	26 to 36	27 to 37	30 to 40	33 to 42	42 to 48
18 to 24	19 to 26	19 to 25	20 to 26	21 to 27	25 to 30	30 to 35
25 to 26	26 to 27	25 to 26	26 to 27	27 to 28	29 to 30	34 to 36
25 to 28	28 to 32	28 to 32	28 to 32	30 to 34	35 to 38	40 to 43
4 75 to 6 25	5 50 to 6 25	5 25 to 6 00	4 50 to 5 00	4 50 to 5 75	7 00	5 75 to 6 75
4 00 to 4 50	4 50 to 5 25	4 75 to 5 25	....	....	....	5 50 to 6 75
4 50 to 5 25	4 50 to 5 25	5 00 to 5 50	....	....	6 00	....
3 75 to 4 50	3 75 to 4 75	4 00 to 4 50	....	....	....	....
6 00 to 8 00	6 00 to 8 00	5 00 to 8 00	....	....	....	....
2 50 to 3 00	2 50 to 3 00	2 50 to 3 25	....	....	....	....
....	....	....	....	....	....	....
1 01 to 1 01¾	1 07	88	86¾	1 04¾ to 1 05½	1 15½ to 1 16¼	1 23¾ to 1 25¼
80	80¾ to 83	77 to 78	81¾ to 82	98 to 99½	1 03 to 1 05	1 10¾ to 1 11¾
52	52 to 55	51½	48 to 48½	55½ to 62	74 to 75	74
....	....	70	80	74 to 74½	83½ to 84	87 to 88
34⅞ to 35⅓	35 to 36	33½ to 34⅜	31½ to 32¼	36½ to 36⅝	41⅞ to 42½	37 to 40⅝
28¾ to 29⅛	28 to 33	23½ to 29½	21½ to 22	24 to 27	32 to 32¼	33¼ to 33½
8 00 to 11 50	9 50 to 11 00	9 00 to 12 00	10 50 to 11 00	11 00 to 12 50	11 50 to 12 50	12 50 to 14 00
7 00 to 9 00	6 00 to 8 50	9 00	Nominal.	8 00 to 9 50	8 00 to 9 00	8 50 to 11 00
9 00 to 9 25	9 00 to 9 25	9 75 to 10 00	9 75 to 10 00	8 25 to 8 50	9 00 to 9 25	8 75 to 9 00
10 00 to 10 25	10 00 to 10 25	10 75 to 11 00	10 75 to 11 00	8 75 to 9 00	9 75 to 10 00	9 00 to 9 50
16 50 to 17 00	16 50 to 15 00	19 00 to 19 50	17 00 to 17 50	13 75 to 14 00	13 50 to 14 00	14 50 to 15 00
9 00 to 9 65	9 00 to 6 85	8 12½ to 8 20	7 90 to 8 00	9 87½ to 9 92½	9 25 to 9 50	12 00
9 00 to 9 50	9 00 to 9 50	Nominal.				
7 75 to 8 00	8 00 to 8 50		....	....	....	....
6 05 to 6 07½	6 10 to 6 12½	5 55 to 5 60	5 50 to 5 55	6 27½ to 6 30	6 10 to 6 25	7 45 to 7 57½
13 to 18	12 to 16	12 to 16	13 to 18	20 to 28	22 to 31	26 to 36
9 to 16	9 to 14	8 to 14	9 to 15	14 to 17	15 to 20	20 to 24
7¼ to 7¾	6 to 6½	5¼ to 6	5 to 5½	9½ to 11	12 to 13	11¾ to 13
1½ to 6	1½ to 5¾	1½ to 5	1 to 4¾	5 to 7½	5 to 12	5 to 11
6½ to 7⅜	....	6¾ to 7½	6½ to 7⅜	7 to 8	8⅛ to 9⅛	7⅝ to 9
15 to 21	18 to 26	20 to 27	19 to 26	19 to 27	22 to 30	29 to 35
26 to 28	30 to 34	31 to 36	30 to 35	31 to 37	35 to 42	40 to 50
25 to 35	30 to 38	35 to 40	34 to 39	34 to 40	36 to 43	40 to 52
10 to 20	....	....	....	....	....	....
3 80 to 4 00	2 90 to 3 15	3 00 to 3 25	3 10 to 3 25	4 40 to 4 50	4 70 to 4 80	4 75 to 5 00
4 25 to 5 10	3 50 to 4 95	3 50 to 4 65	3 40 to 4 30	4 60 to 5 10	5 20 to 5 40	5 10 to 5 80
5 30 to 6 10	5 00 to 5 90	4 70 to 5 50	4 35 to 5 25	5 50 to 6 25	5 90 to 6 35	5 85 to 6 50
1 08 to 1 20	90 to 97	85 to 98	90 to 94	1 07½	1 20 to 1 28	1 28 to 1 30
1 10 to 1 13	92¼ to 1 00½	93 to 99¾	84½ to 94	1 03¾ to 1 09¾	1 11 to 1 27	1 21 to 1 28
....	....	....	80	....	1 04 to 1 26	....
34⅝ to 39	34½ to 41	33¼ to 42¼	31 to 39	34¾ to 42½	32 to 43	38¼ to 45
46½ to 52½	48½ to 50	49 to 51½	47	60 to 61	72 to 75	74 to 78
58	65	....	60 to 68	....	60 to 85	60 to 85
31	29 to 30	25½ to 27⅝	22½ to 24	22 to 24½	28 to 34	31 to 37
10 50 to 13 50	10 00	....	12 00 to 14 00	12 25 to 15 50	14 50 to 17 00	15 00 to 16 50
....	....	13 00	10 50 to 10 75	....	9 50 to 10 00	11 00
....	....	....	10 00 to 11 00	....	....	....

MARKET PRICES OF FARM

Products.	January.	February.	March.	April.	May.
SAINT LOUIS—Cont'd.					
Beef—Continued.					
Extra family ......bbl..	$11 50	....	....	....	....
Pork, mess ....do..	$7 50 to 8 00	$9 50 to $10 37½	$9 80 to $10 37½	$10 30 to $10 65	$9 75 to $10 25
Lard..............cental.	6 00 to 6 12½	6 00 to 6 75	6 25 to 7 12½	7 00 to 7 25	5 72½ to 6 75
Butter:					
Extra choice creamery, pound	24 to 28	28 to 30	25 to 28	25 to 28	20 to 22
Fair to choice dairy, tubs ....lb.	14 to 20	14 to 20	12½ to 22	10 to 22	15 to 17
Cheese:					
New York and Ohio factory ....lb.	7½ to 8	6½ to 7½	6½ to 7½	6½ to 7½	7 to 8
Western factory...do..	6½ to 7½	6 to 6½	6 to 6½	6 to 6½	7 to 7½
Tobacco:					
Lugs ....cental..	1 75 to 3 00	1 75 to 3 00	1 75 to 3 00	1 90 to 3 50	1 90 to 3 50
Common to medium leaf...........cental.	3 25 to 5 50	3 25 to 5 50	3 25 to 5 00	3 50 to 7 00	3 50 to 7 00
Wool:					
Tub, washed........lb.	25 to 31	24 to 31½	24 to 30½	25 to 32½	24 to 33
Unwashed comb'g.do..	16 to 22	16 to 23½	16 to 21½	16 to 21½	16 to 22
Texas	....	....	....	....	....
NEW ORLEANS.					
Flour:					
Superfine..........bbl.	3 50 to 3 75	3 25	3 00	3 00	3 00
Extra ....do..	4 12½ to 5 00	3 50 to 4 50	3 50 to 4 75	3 00 to 4 75	3 00 to 4 75
Choice to fancy....do..	5 00 to 5 62½	4 50 to 5 50	4 87½ to 6 00	4 87½ to 6 12½	4 87½ to 5 85
Wheat:					
No. 2, winter .....bush.	1 02	1 06 to 1 08	1 10 to 1 11	1 12	1 12 to 1 13
Spring ....do..	....	....	....	....	....
Corn ....do..	41½ to 42	41 to 41½	42 to 42½	40½ to 41	46 to 50
Oats................do..	31 to 32	32½ to 33	37 to 38	35½ to 37	34½ to 35
Hay:					
Prime ....ton.	13 00 to 15 00	13 00 to 15 00	15 00 to 16 00	12 50 to 14	15 50 to 16 50
Choice ....do..	16 00 to 17 00	16 00	17 00 to 18 00	15 00 to 16 00	17 50 to 18 00
Beef:					
Western mess.....bbl.	12 50 to 14 00	10 50	10 00 to 12 00	10 75 to 12 00	10 75 to 12 00
Western mess, extra, barrel	....	....	....	....	....
Texas ....bbl.	....	....	....	9 00	9 00
Fulton Market...½-bbl.	8 25	8 00 to 8 25	8 00 to 8 50	8 00 to 8 25	8 00 to 8 25
Pork, mess .... bbl.	7 50 to 8 25	8 75 to 9 87½	9 50 to 11 00	9 50 to 11 50	9 25 to 10 75
Lard ....cental.	6 25 to 7 00	6 25 to 7 00	6 50 to 7 87½	6 25 to 7 75	6 75 to 7 75
Butter:					
New York prime to choice ....lb.	23 to 27	22 to 27	21 to 26	20 to 25	18 to 25
Western prime to choice ....lb.	12 to 28	12 to 28	12 to 30	12 to 28	12 to 27
Cheese:					
Western factory ....lb.	7 to 8	6½ to 8	5 to 7	6½ to 8	7 to 9
New York cream..do..	10 to 11	10½ to 11	10 to 10½	10 to 10½	10 to 11
Sugar:					
Fair to fully fair....lb.	5 to 5⅜	5⅛ to 5⅞	5½ to 5⅝	5⅝ to 5¾	5⅝ to 5¾
Prime to strictly prime, pound	5¼ to 5¾	5½ to 5¾	5¾ to 6	5⅝ to 6	5⅞ to 6½
Clarified white and yellow ....lb.	6½ to 8	6½ to 8⅜	6¾ to 8	6¾ to 7⅞	6¾ to 7¾
Cotton:					
Ordinary to good ordinary ....lb.	7⅝ to 8⅜	8 to 8½	8¼ to 8¾	9½ to 10⅛	10¼ to 10¾
Low middling to good middling..........lb.	8½ to 10	8⅝ to 9⅞	8⅞ to 9⅞	10¼ to 11¼	10⅞ to 11¾
Middling fair.......do.	10⅝ to 10⅞	10⅝ to 10¾	10¾ to 10⅞	11⅜ to 11¾	11⅞ to 12⅛
Good and fine.......do.	....	....	....	....	....
Tobacco:					
Lugs ....lb.	2¼ to 3	2¼ to 3	2¼ to 3	2¼ to 3¾	2½ to 4¼
Leaf, low to medium, pound	4 to 6½	4 to 6½	4 to 6½	4 to 6¼	4¼ to 6½
Wool:					
Louisiana clear .....lb.	18 to 20	18 to 20	18 to 20	18	17 to 18
Clear Lake ....do..	19 to 21	19 to 21	19 to 21	....	19 to 20
SAN FRANCISCO.					
Flour:					
Superfine..........bbl.	4 00 to 4 25	4 00 to 4 25	4 00 to 4 25	4 00 to 4 25	4 00 to 4 25
Extra ....do..	4 30 to 4 50	4 30 to 4 50	4 50 to 4 75	4 50 to 4 75	4 00 to 4 75
Family and fancy..do..	4 00 to 5 50	4 00 to 5 50	5 00 to 5 25	5 00 to 5 50	5 00 to 5 75

PRODUCTS FOR 1879—Continued.

June.	July.	August.	September.	October.	November.	December.
$12 00	$12 00	$12 00	$12 00	$12 00	$12 00	$12 50
$10 00 to 10 37½	$10 35 to 10 65	$9 50	$8 45 to 8 75	$10 50 to 10 60	10 30	$11 25 to 11 50
5 62½ to 6 87½	6 00 to 7 00	6 75 to 6 87½	5 50 to 6 87½	6 75 to 7 87½	$5 75 to 7 00	6 70
17 to 18	15 to 18	14 to 18	17 to 20	26 to 28	27 to 30	33 to 35
10 to 15	9 to 14	9 to 14	8 to 15	16 to 22	18 to 24	22 to 28
7 to 8	7 to 8	7 to 8	7 to 8	11½	11½	13¾ to 14½
7 to 7½	7 to 7½	7 to 7½	7 to 7½	10½ to 11	10½ to 11	12¾ to 13½
1 80 to 3 20	2 50 to 5 00	2 50 to 5 00	2 70 to 5 00	2 70 to 6 00	2 70 to 6 00	2 80 to 7 00
3 25 to 6 50	4 25 to 9 00	4 00 to 9 00	4 00 to 9 00	4 00 to 9 00	4 00 to 9 00	4 25 to 9 00
29 to 37	30 to 38	30 to 36	32 to 39	30 to 43	35 to 45	50 to 55
17 to 26	17 to 26	17 to 25	17 to 25½	19 to 28	19 to 28	28 to 32
....	....	....	....	....	25 to 29	28 to 32
4 00	3 50 to 4 00	3 25 to 3 50	3 25 to 3 50	4 25 to 4 50	4 50 to 4 75	....
4 90 to 5 50	4 25 to 5 25	4 00 to 4 50	3 75 to 4 55	4 75 to 5 62½	5 00 to 6 25	5 95 to 6 75
5 75 to 6 37½	5 50 to 6 12½	5 00 to 5 75	5 to to 5 37½	5 75 to 6 25	6 50 to 7 00	6 75 to 7 25
1 22	1 04 to 1 05	1 08 to 1 10	....	Nominal.	Nominal.	Nominal.
....	....	....	....	Nominal.	Nominal.	Nominal.
50 to 57	48 to 52	41¾ to 42	42½ to 43	55 to 60	62 to 65	52 to 55
43½ to 45	38 to 38½	35 to 36	34	38 to 39	40 to 41	44 to 47
18 00	17 00 to 18 00	19 00	18 00 to 19	....	21 00 to 23	18 50 to 19 50
22 00	20 00	20 00 to 21 00	22 00 to 23 00	24 00 to 25 00	24 00 to 25 00	22 00
10 75 to 12 00	9 50 to 13 00	9 50 to 13 00	11 75 to 12 00	10 00 to 12 00	12 00 to 12 50	10 00 to 13 00
....	....	....	....	....	....	....
9 00	....	....	....	....	....	....
8 00 to 8 25	....	....	7 75 to 8 00	7 75 to 8 00	8 75	9 25 to 9 50
10 75 to 11 00	10 50 to 11 00	9 50 to 10 00	9 00 to 9 75	10 00 to 12 50	12 00 to 12 50	12 75 to 13 25
6 75 to 7 75	7 12½ to 7 25	6 75 to 7 87½	6 50 to 7 50	6 87½ to 7 75	7 25 to 8 00	8 00 to 8 50
11 to 23	14 to 20	12 to 18	15 to 22	17 to 30	16 to 22	18 to 32
12 to 23	11 to 20	10 to 19	13 to 22	25 to 30	17 to 30	17 to 30
7	4 to 6	6	4½ to 7½	10 to 12	12½ to 13	13
10	10 to 10½	9	9 to 9½	12½ to 13½	14 to 15	15
6⅛ to 6¼	6⅜ to 6¾	6½ to 7	7 to 7¼	8¼	6¾	6⅝ to 7¼
6⅜ to 6½	6⅞	7¼	7½	9	....	7½ to 7¾
6¾ to 7¾	7¼ to 8	7⅞ to 8	7½ to 8¼	8½	8¼ to 8⅞	8 to 9½
11⅜ to 12	10⅝ to 11¼	9½ to 10¼	9¾ to 10⅜	8¾ to 9⅜	9 to 10⅛	10¾ to 11⅛
12½ to 13	11½ to 12½	10¾ to 11⅝	10⅜ to 11⅜	9⅞ to 10¾	10⅝ to 10⅞	11¼ to 12⅛
13 to 13¼	12½ to 12¾	11¾ to 11⅞	11⅞ to 12	11 to 11¼	11⅛ to 11¼	12⅛ to 12⅜
....	....	....	....	....	....	12¾ to 13
2½ to 4¼	2½ to 4	2½ to 4	3¾ to 5	3½ to 5	3¼ to 4¾	3¼ to 4¾
4½ to 6½	4½ to 6½	4½ to 6½	5¼ to 7¼	5¼ to 7¼	5 to 7¼	5 to 7¼
25 to 27	26 to 27	22 to 24	21½	25	28 to 31	28 to 31
28 to 30	28	24 to 25	23 to 25	28	30 to 32	30 to 32
4 00 to 4 25	4 00 to 4 25	4 00 to 4 25	4 00 to 4 25	4 25 to 5 00	4 25 to 4 50	4 25 to 4 50
4 50 to 4 75	4 50 to 4 75	4 50 to 4 75	4 50 to 4 75	5 25 to 5 75	5 00 to 5 50	5 00 to 5 50
5 00 to 5 75	5 00 to 5 75	5 00 to 5 75	5 00 to 5 75	6 00	6 00 to 6 50	6 00 to 6 75

MARKET PRICES OF FARM

Products.	January.	February.	March.	April.	May.
SAN FRANCISCO—Cont'd.					
Wheat:					
California ....cental.	$1 25 to $1 75	$1 25 to $1 75	$1 15 to $1 72½	$1 15 to $1 70	$1 15 to $1 65
Oregon ....do..	1 50 to 1 70	1 50 to 1 75	1 50 to 1 72½	1 50 to 1 65	1 50 to 1 60
Barley..................do..	95 to 1 25	85 to 1 25	67½ to 1 25	70 to 1 15	60 to 1 10
Oats....................do..	1 25 to 1 65	1 15 to 1 50	1 15 to 1 50	1 00 to 1 35	1 00 to 1 35
Corn ....do..	1 00 to 1 05	90 to 1 00	85 to 1 00	90 to 95	87½ to 95
Hay, State.............ton.	8 00 to 13 50	10 00 to 16 50	7 50 to 15 00	6 50 to 13 50	6 00 to 13 00
Pork:					
Mess ....bbl.	16 00 to 17 00	16 00 to 17 00	16 00 to 17 00	16 00 to 17 00	16 00 to 17 00
Prime mess..........do.	15 00 to 15 50	15 00 to 15 50	15 00 to 15 50	15 00 to 15 50	15 00 to 15 50
Beef:					
Mess ....bbl.	8 00 to 9 00	8 00 to 9 00	8 00 to 9 00	8 00 to 9 00	8 00 to 9 00
Family mess......½-bbl.	8 00 to 8 50	8 00 to 8 50	8 00 to 8 50	8 00 to 8 50	8 00 to 8 50
Lard.....................lb.	8 to 11	8 to 11	8 to 9½	8 to 9	8 to 9
Butter:					
Overland..............lb.	15 to 16	15 to 16	15 to 16	15	15
California ....do..	20 to 37½	20 to 35	20 to 30	20 to 22½	20 to 22
Oregon ....do..	15 to 16	15 to 16	15 to 16	15	15 to 16
Cheese ....do..	10 to 16	10 to 16	10 to 16	10 to 15	10 to 15
Wool:					
Native.................lb..	8 to 15	8 to 15	8 to 15	8 to 10	8 to 10
California ....do..	16 to 20	16 to 20	16 to 18	16 to 18	16 to 18
Oregon ....do..	15 to 20	15 to 20	15 to 18	15 to 18	15 to 18

LIVE-STOCK

NEW YORK.					
Cattle:					
Extra beeves ...cental.	$10 25 to $10 50	$10 25 to $10 50	$10 50 to $10 75	$10 50 to $10 75	$10 50 to $10 75
Good to prime......do..	8 75 to 10 00	9 00 to 10 00	8 75 to 10 75	9 50 to 10 50	9 25 to 10 25
Common to fair.....do..	7 50 to 8 50	7 75 to 8 75	8 60	8 25 to 9 25	8 50 to 9 00
Poor to common...do..	....	6 75 to 7 50	....	7 00 to 8 00	....
Texas and Cherokee, cental	....	....	....	....	....
Milch cows ......head.	40 00 to 60 00	35 00 to 65 00	50 00 to 60 00	30 00 to 50 00	45 00
Veal calves .....cental.	2 50 to 7 50	2 75 to 7 50	6 50 to 7 50	4 00 to 6 00	2 50 to 5 00
Sheep ....do.	4 00 to 5 00	4 00 to 5 50	4 87½ to 6 00	5 12½ to 7 00	4 50 to 6 50
Swine ....do.	2 90 to 3 10	3 50	4 25 to 4 60	4 37½	3 80 to 4 00
CINCINNATI.					
Cattle:					
Fair to good shipping steers..........cental.	4 00 to 4 75	4 25 to 4 75	4 25 to 4 75	4 50 to 5 20	4 50 to 5 00
Common to choice butchers' grades.....cental.	1 25 to 4 00	1 50 to 4 35	2 00 to 4 50	2 [illegible] to 5 00	2 00 to 5 00
Cows, heifers, &c ...do.	2 50 to 3 75	2 50 to 4 00	2 50 to 4 25	3 00 to 4 75	3 60 to 4 65
Sheep ....do.	2 00 to 4 50	3 00 to 5 25	3 00 to 4 75	3 00 to 5 25	3 00 to 5 00
Swine ....do.	2 25 to 3 00	2 60 to 3 85	3 00 to 4 20	2 90 to 4 25	2 50 to 3 75
CHICAGO.					
Cattle:					
Extra beeves ...cental.	4 60 to 5 00	4 75 to 5 25	4 80 to 5 00	4 85 to 5 10	4 85 to 5 15
Choice beeves......do..	4 10 to 4 35	4 25 to 4 50	4 50 to 4 70	4 60 to 4 70	4 50 to 4 70
Good beeves........do..	3 60 to 4 00	3 50 to 4 00	4 00 to 4 40	4 20 to 4 50	4 20 to 4 40
Medium grades.....do..	3 00 to 3 50	3 25 to 3 50	3 75 to 4 00	3 85 to 4 15	3 85 to 4 15
Inferior natives ...do..	1 75 to 2 00	1 80 to 2 25	2 00 to 2 50	2 00 to 2 50	2 00 to 2 50
Texans ....do..	....	....	....	....	....
Veal calves.........do..	2 75 to 4 50	3 00 to 4 75	3 00 to 5 00	3 00 to 5 00	3 00 to 5 00
Sheep ....do..	2 75 to 4 25	3 00 to 4 60	3 25 to 5 00	3 75 to 5 75	3 50 to 5 75
Swine ....do..	2 65 to 3 00	2 00 to 3 75	3 00 to 4 00	3 70 to 4 15	3 25 to 3 60
SAINT LOUIS.					
Cattle:					
Choice natives..cental.	4 35 to 4 85	4 75 to 5 25	4 60 to 5 10	4 80 to 5 15	4 75 to 5 10
Fair to prime natives, cental	3 37½ to 3 85	4 00 to 4 55	4 20 to 4 35	4 65 to 4 80	4 25 to 4 70
Fair to good butchers' steers..........cental.	2 75 to 3 50	3 60 to 4 00	3 85 to 4 00	4 12½ to 4 65	3 75 to 4 40
Common to good stock steers ....cental.	2 50 to 2 65	2 25 to 2 75	2 00 to 2 90	3 25 to [illegible]	3 00 to 3 75
Texans and Cherokees, cental	2 75 to 3 50	....	....	3 80 to 4 70	3 50 to 4 50
Sheep ....cental.	2 00 to 4 25	2 25 to 4 75	3 50 to 5 50	4 00 to 5 50	3 00 to 4 70
Swine ....do..	2 20 to 2 75	3 40 to 3 90	3 50 to 4 30	2 90 to 4 15	2 50 to 3 75

PRODUCTS FOR 1879—Continued.

June.	July.	August.	September.	October.	November.	December.
$1 15 to $1 70	$1 50 to $1 72½	$1 50 to $1 75	$1 50 to $1 72½	$1 85 to $1 95	$1 60 to $2 00	$1 60 to $2 10
1 50 to 1 65	1 50 to 1 65	1 50 to 1 70	1 50 to 1 70	....	1 60 to 2 00	1 60 to 2 05
65 to 95	65 to 95	65 to 1 00	65 to 1 02½	65 to 95	65 to 95	65 to 1 00
1 25 to 1 50	1 25 to 1 40	1 25 to 1 50	1 25 to 1 50	1 25 to 1 50	1 25 to 1 40	1 25 to 1 35
72½ to 80	75 to 90	70 to 75	85 to 92½	85 to 95	90 to 1 00	95 to 1 05
6 00 to 13 00	5 00 to 12 50	5 00 to 10 50	6 00 to 11 00	6 00 to 10 00	7 00 to 12 00	8 00 to 13 50
16 00	16 00 to 16 50	16 00 to 16 50	14 00 to 15 50	14 00 to 15 50	15 00 to 15 50	15 00 to 15 50
14 00 to 15 00	14 00 to 15 00	14 00 to 15 00	13 00 to 14 00	13 00 to 14 00	11 00 to 12 50	11 00 to 12 50
7 50 to 9 50	7 50 to 9 50	7 50 to 9 50	7 50 to 9 50	7 50 to 9 50	7 50 to 8 50	7 50 to 8 50
8 00 to 8 50	8 00 to 8 50	5 00 to 6 00	5 00 to 6 00	5 00 to 6 00	7 00 to 7 50	7 00 to 7 50
8 to 9	8 to 9	7½ to 9½	6 to 9½	6 to 8½	7½ to 8½	7½ to 9
15	15	12½ to 15	12½ to 15	12½ to 15	12½ to 15	12½ to 15
20 to 22	18 to 20	18 to 20	20 to 30	20 to 30	20 to 30	20 to 30
15 to 16	15 to 16	14 to 15	14 to 15	14 to 15	14 to 15	14 to 15
10 to 15	10 to 15	10 to 15	10 to 15	10 to 15	10 to 15	10 to 18
12½ to 15	12½ to 15	12 to 15	12 to 15	12 to 15	12 to 15	15 to 16
16 to 25	16 to 28	16 to 26	16 to 26	16 to 26	16 to 28	16 to 30
18 to 25	18 to 28	18 to 26	18 to 26	18 to 26	18 to 28	18 to 30

MARKETS.

....	$9 50 to $10 00	$10 50	$10 50 to $10 75	$9 75 to $10 00	$9 75 to $10 25	$10 00 to $10 50
$8 25 to $9 50	8 00 to 9 25	$7 75 to 10 00	7 75 to 10 25	8 75 to 9 50	7 50 to 9 50	7 75 to 9 75
8 00 to 8 50	7 50	....	....	7 00 to 8 50	6 25 to 7 00	7 25 to 7 75
6 50 to 7 00	....	....	....	....	....	....
6 00 to 6 50	....	6 50 to 7 00	6 50 to 6 75	....	....	....
35 00 to 55 00	30 00 to 50 00	25 00 to 35 00	30 00 to 45 00	35 00 to 48 00	40 00 to 60 00	40 00 to 60 00
2 75 to 6 00	2 50 to 5 50	2 37 to 6 25	2 25 to 5 50	4 00 to 6 25	2 25 to 7 25	2 00 to 7 50
3 50 to 5 75	3 00 to 5 62½	3 75 to 5 75	3 75 to 5 25	3 50 to 5 00	3 00 to 4 80	5 25 to 5 50
3 70 to 3 90	....	4 00 to 4 25	3 60 to 3 80	4 00 to 4 30	3 90 to 4 30	3 50 to 4 31
4 00 to 4 50	3 75 to 4 35	3 75 to 4 50	4 00 to 4 50	3 85 to 4 40	3 80 to 4 60	3 90 to 4 50
1 75 to 4 40	1 75 to 4 25	1 50 to 4 00	1 50 to 4 00	1 50 to 3 75	1 50 to 3 60	1 40 to 3 60
3 00 to 4 25	3 00 to 4 00	2 75 to 3 75	3 00 to 4 00	3 00 to 3 65	3 00 to 3 50	2 00 to 2 50
2 50 to 4 25	2 25 to 4 75	2 00 to 4 00	2 00 to 4 25	2 35 to 4 25	2 25 to 4 25	2 50 to 4 50
2 50 to 3 60	3 00 to 4 00	2 75 to 3 70	2 60 to 3 70	2 80 to 3 85	3 00 to 4 00	3 50 to 4 75
4 80 to 5 10	4 75 to 4 90	4 80 to 5 15	5 00 to 5 30	4 65	4 70 to 4 90	4 65 to 4 85
4 65 to 4 75	4 40 to 4 60	4 40 to 4 60	....	....	4 35 to 4 60	4 25 to 4 50
4 25 to 4 50	4 10 to 4 40	4 00 to 4 10	....	....	3 80 to 4 20	3 75 to 4 15
4 00 to 4 25	3 75 to 4 00	3 50 to 3 90	....	3 25 to 4 00	3 25 to 3 75	3 15 to 3 65
1 50 to 2 00	2 00 to 2 40	1 75 to 2 25	2 00 to 3 50	2 25 to 2 75	1 50 to 2 25	1 75 to 2 00
....	2 75 to 3 50	2 25 to 2 80	2 25 to 2 65	2 40 to 2 60	2 40 to 3 10	....
3 00 to 4 75	3 25 to 5 25	3 25 to 5 00	....	....	3 00 to 4 75	2 75 to 4 75
2 75 to 5 50	2 25 to 4 75	2 50 to 4 75	2 50 to 4 75	2 50 to 4 25	3 00 to 3 75	3 00 to 4 25
2 75 to 3 60	3 00 to 3 85	2 25 to 3 75	3 00 to 3 75	3 15 to 3 80	3 40 to 3 95	4 00 to 4 70
4 75 to 5 00	4 70 to 5 00	4 70 to 4 80	4 70 to 4 85	4 70 to 4 80	4 70 to 4 80	4 50 to 4 70
4 25 to 4 70	4 15 to 4 65	4 15 to 4 65	3 75 to 4 60	3 75 to 4 60	3 75 to 4 60	3 50 to 4 40
3 75 to 4 40	3 75 to 4 25	3 75 to 4 40	3 00 to 3 60	3 00 to 3 60	3 00 to 3 60	3 00 to 3 60
3 00 to 3 75	2 25 to 3 40	3 00 to 3 75	2 00 to 3 25	2 00 to 2 75	2 00 to 2 75	2 00 to 2 75
3 00 to 4 00	3 00 to 4 00	3 00 to 4 00	2 25 to 3 75	....	2 27 to 3 75	2 25 to 3 75
3 20 to 3 45	2 75 to 3 12½	2 50 to 2 95	2 15 to 3 25	2 00 to 4 25	2 25 to 4 15	2 25 to 4 00
2 75 to 3 60	3 40 to 4 00	3 45 to 4 00	2 80 to 3 55	2 50 to 3 75	2 90 to 3 80	3 20 to 4 00

LIVE-STOCK

Products.	January.	February.	March.	April.	May.
SAINT LOUIS—Cont'd.					
Horses:					
Plugs ....head.	$10 00 to $30 00	$15 00 to $35 00	$15 00 to $35 00	$15 00 to $35 00	$15 00 to $35 00
Southern horses ...do..	25 00 to 80 00	30 00 to 85 00	30 00 to 85 00	30 00 to 90 00	30 00 to 90 00
Streeters ....do..	75 00 to 90 00	75 00 to 90 00	75 00 to 85 00	75 00 to 90 00	75 00 to 90 00
Heavy draft.......do..	90 00 to 190 00	95 00 to 190 00	95 00 to 190 00	95 00 to 190 00	95 00 to 190 00
Saddle horses......do..	....	....	....	....	....
Extra drivers......do..	110 00 to 170 00	110 00 to 170 00	110 00 to 170 00	110 00 to 170 00	110 00 to 170 00
Good matches ......do..	250 00 to 400 00	250 00 to 400 00	250 00 to 400 00	250 00 to 400 00	250 00 to 400 00
Mules:					
14 to 15 hands high.do..	55 00 to 95 00	40 00 to 80 00	35 00 to 75 00	35 00 to 80 00	35 00 to 100 00
15 to 16 hands high.do..	80 00 to 140 00	60 00 to 120 00	55 00 to 115 00	55 00 to 115 00	75 00 to 130 00
16 to 16½ hands high.do..	115 00 to 140 00	100 00 to 120 00	95 00 to 115 00	95 00 to 115 00	95 00 to 130 00
NEW ORLEANS.					
Cattle:					
Corn-fed beeves.cental.	2 00 to 4 50	2 00 to 4 50	2 50 to 5 00	3 50 to 5 00	3 00 to 5 00
Choice Texas beeves, head	....	....	....	....	....
Texas, 1st quality.head.	30 00 to 35 00	30 00 to 35 00	30 00 to 35 00	30 00 to 35 00	30 00 to 35 00
Texas, 2d quality ..do..	15 00 to 25 00	15 00 to 25 00	15 00 to 25 00	15 00 to 25 00	15 00 to 25 00
Milch cows.........do..	30 00 to 90 00	30 00 to 90 00	25 00 to 75 00	25 00 to 75 00	25 00 to 75 00
Calves ....do..	6 00 to 8 00	6 00 to 9 00	6 00 to 9 00	6 00 to 9 00	6 00 to 9 00
Sheep ....do..	2 00 to 4 00	2 00 to 4 00	2 00 to 4 50	2 00 to 4 50	2 00 to 4 50
Swine ....do..	3 00 to 4 00	2 50 to 3 50	3 50 to 4 50	3 00 to 3 50	3 00 to 4 50
Horses:					
Common ....do..	50 00 to 100 00	50 00 to 100 00	50 00 to 100 00	50 00 to 100 00	50 00 to 100 00
Plugs ....do..	....	....	....	....	....
Good working .....do..	100 00 to 175 00	100 00 to 175 00	100 00 to 175 00	100 00 to 175 00	100 00 to 175 00
Mules:					
First-class.........do..	175 00 to 225 00	175 00 to 225 00	175 00 to 225 00	175 00 to 225 00	175 00 to 225 00
For sugar plantations, head	....	....	....	....	....
For city use.....head..	175 00 to 225 00	175 00 to 225 00	175 00 to 225 00	175 00 to 225 00	175 00 to 225 00
For rice culture, small, head	100 00 to 150 00	100 00 to 150 00	100 00 to 150 00	100 00 to 150 00	100 00 to 150 00

MARKETS—Continued.

June.	July.	August.	September.	October.	November.	December.
$20 00 to $40 00	$25 00 to $40 00	$25 00 to $40 00	$25 00 to $40 00	$25 00 to $40 00	$20 00	$25 00 to $40 00
30 00 to 85 00	40 00 to 70 00	40 00 to 70 00	40 00 to 70 00	30 00 to 70 00	$40 00 to 70 00	30 00 to 70 00
85 00 to 110 00	80 00 to 100 00	80 00 to 100 00	70 00 to 100 00	80 00 to 100 00	80 00 to 90 00	80 00 to 100 00
100 00 to 150 00	90 00 to 140 00	90 00 to 140 00	90 00 to 135 00	90 00 to 125 00	85 00 to 130 00	90 00 to 125 00
75 00 to 150 00	75 00 to 150 00	75 00 to 150 00	75 00 to 150 00	75 00 to 150 00	70 00 to 125 00	75 00 to 150 00
100 00 to 145 00	125 00 to 175 00	125 00 to 175 00	125 00 to 200 00	125 00 to 200 00	85 00 to 135 00	85 00 to 200 00
250 00 to 400 00	250 00 to 400 00	225 00 to 400 00	....	....	....	....
55 00 to 85 00	50 00 to 90 00	55 00 to 95 00	50 00 to 90 00	50 00 to 90 00	50 00 to 85 00	50 00 to 70 00
75 00 to 140 00	85 00 to 140 00	85 00 to 140 00	85 00 to 135 00	90 00 to 140 00	85 00 to 140 00	75 00 to 140 00
110 00 to 140 00	110 00 to 140 00	110 00 to 140 00	110 00 to 165 00	110 00 to 175 00	110 00 to 175 00	110 00 to 175 00
3 00 to 4 50	....	....	....	....	2 50 to 4 00	2 50 to 4 00
25 00 to 30 00	30 00 to 35 00	30 00 to 35 00	30 00 to 35 00	....	....	....
20 00 to 24 00	24 00 to 28 00	24 00 to 28 00	24 00 to 28 00	....	....	....
15 00 to 18 00	15 00 to 20 00	15 00 to 20 00	15 00 to 20 00	....	....	....
25 00 to 75 00	25 00 to 75 00	25 00 to 75 00	25 00 to 75 00	35 00 to 80 00	35 00 to 80 00	35 00 to 80 00
6 00 to 9 00	5 00 to 8 00	5 00 to 8 00	5 00 to 8 00	5 00 to 8 00	7 00 to 9 00	7 00 to 9 00
2 00 to 4 00	2 00 to 4 00	2 00 to 4 00	2 00 to 4 00	2 00 to 4 00	2 00 to 4 00	2 00 to 4 00
3 00 to 4 50	3 00 to 4 50	3 00 to 4 50	3 00 to 4 50	3 00 to 4 50	3 50 to 4 50	3 00 to 4 50
50 00 to 100 00	50 00 to 100 00	50 00 to 90 00	50 00 to 90 00	50 00 to 90 00	....	....
....	....	....	....	....	50 00 to 90 00	45 00 to 75 00
100 00 to 175 00	100 00 to 175 00	90 00 to 110 00	90 00 to 120 00	90 00 to 100 00	90 00 to 120 00	90 00 to 100 00
175 00 to 225 00	175 00 to 225 00	....	175 00 to 225 00	140 00 to 210 00	....	....
....	....	125 00 to 190 00	....	....	160 00 to 190 00	150 00 to 210 00
175 00 to 225 00	175 00 to 225 00	110 00 to 200 00	140 00 to 210 00	....	160 00 to 200 00	150 00 to 210 00
100 00 to 150 00	100 00 to 150 00	....	100 00 to 110 00	100 00 to 120 00	105 00 to 135 00	100 00 to 120 00

PORK PACKING.

The following statistics have been compiled from the annual report of the Cincinnati Price Current. The "packing year" consists of a "summer season," from March 1 to November 1, and a "winter season," from November 1 to March 1. The importance of the summer season for operations in pork is increasing, and with the abundant supply of ice during the summer of 1879, there was a large increase in number packed during the summer as compared with the number in the year previous. The great pork-producing region of our country is in

THE WEST.

SUMMER PACKING.—The summer-packing season of 1879 opened with a fair supply, and at prices not much changed from the year previous. The numbers packed, weight per head, and the yield of lard during the last four summer seasons were as follows:

Season.	Numbers.	Aggregate net weight.	Average net weight per head.	Aggregate yield of lard.	Average yield of lard per head.
		Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
1876	2,357,866	424,879,300	184.10	70,040,980	30.35
1877	2,543,120	484,553,471	190.57	85,364,176	33.56
1878	3,378,044	631,807,730	187.03	113,949,500	33.73
1879	4,051,248	743,525,500	183.53	129,580,672	31.98

The numbers packed at the six leading cities, Chicago, Cincinnati, Saint Louis, Milwaukee, Louisville, and Indianapolis, together with other prominent points, during the last three years, were as follows:

Packing points.	1876.	1877.	1878.	1879.
Chicago	1,315,402	1,508,026	2,017,841	2,155,418
Cincinnati	121,173	134,416	154,517	149,934
Saint Louis	131,158	148,277	142,000	350,000
Milwaukee	60,827	54,785	107,053	67,537
Louisville	9,500	19,800	25,000	25,000
Indianapolis	283,621	204,264	312,224	243,500
Total for the six cities	1,921,681	2,069,568	2,758,635	2,991,389
Cleveland, Ohio	187,392	146,048	229,385	319,865
Cedar Rapids, Iowa	105,580	110,130	195,200	141,685
Kansas City, Mo	66,754	77,821	99,517	145,638
Des Moines, Iowa	28,609	31,503	12,027	49,800
Detroit, Mich	24,000	34,028	30,302	61,675
Other points	23,850	71,022	52,978	341,196
Grand total	2,357,866	2,543,120	3,378,044	4,051,248

WINTER PACKING.—The record of number of hogs packed in the West during the winter season of 1879–'80 shows a total of 6,950,451, against 7,480,648 in 1878–'9, the decrease in head being 530,197, and at same weight as 1878–'9, the decrease is equal to 664,453 hogs, or 9 per cent. At the six large cities there was a decrease of 726,508 hogs, and at all other or interior places an increase of 196,311, compared with the preceding year. The gains and losses by States are shown in an accompanying table. The aggregate number packed for twelve months ending March 1, 1880, is 11,001,699, which exceeds the previous year 143,007.

THE AVERAGE WEIGHT.

The average weight of hogs packed during the winter was 212.94 pounds net, a decrease of 4.20 pounds, or $5\frac{1}{4}$ pounds gross. All States show a decrease, excepting Indiana, the average of which is slightly greater than last year, owing to an increased average at Indianapolis, where 60 per cent. of the number were packed, the other packing in the State showing a large falling off in the average weight, compared with last year. Nebraska and Kansas show the largest falling off in average, the next in order being Tennessee, Ohio, Kentucky, Missouri, &c. The gains and losses by States are shown in an accompanying table. The aggregate net weight of the winter packing was 1,480,068,518 pounds, or 144,282,746 pounds less than the preceding winter.

THE YIELD OF LARD.

The general average yield of lard per hog for the winter shows 36.32 pounds, a decrease of 3.08 pounds, which is relatively greater than the falling off in weight, but this is consistent with the understood manufacture during the season, and the difference in lard-yielding quality of hogs. The percentage yield of lard is 17.06 of net weight, against 18.14 per cent. last year, and 17.08, 15.78, and 16.28 in the three previous years, respectively. The aggregate production of lard for the winter was 252,439,188 pounds, or 764,967 tierces of 330 pounds each, being a decrease of 42,313,170 pounds, or 128,221 tierces, compared with the preceding winter.

COST OF HOGS.

The average cost of hogs for the winter is $5.22 per 100 pounds net, or $4.18 gross, and is $1.66 per 100 pounds net, or $1.33 gross greater than the preceding year. The aggregate cost of hogs was $77,231,648, being an increase of $19,402,056, while there was a deficiency of 144,282,746 pounds, or 9 per cent. in net weight. The average cost per 100 pounds is 47 per cent. greater than the preceding year. The average price paid during the past ten winter seasons is $4.79 per 100 pounds gross, or $5.99 net.

The following table shows the comparative receipts of the last four winter seasons:

States.	1876-'77.		1877-'78.		1878-'79.		1879-'80.	
	Number packed.	Per cent. of the whole.	Number packed.	Per cent. of the whole.	Number packed.	Per cent. of the whole.	Number packed.	Per cent. of the whole.
Ohio	813, 709	15. 93	934, 132	14. 36	932, 878	12. 47	914, 964	13. 16
Indiana	530, 286	10. 37	496, 025	7. 63	682, 321	9. 12	604, 186	8. 69
Illinois	1, 905, 219	37. 28	2, 714, 748	41. 73	3, 214, 896	42. 97	2, 784, 754	40. 07
Iowa	419, 442	8. 21	486, 850	7. 49	569, 703	7. 59	658, 085	9. 47
Missouri	644, 699	12. 61	804, 614	12. 37	965, 839	12. 91	926, 931	13. 34
Kansas	31, 775	. 62	41, 470	. 64	132, 346	1. 78	137, 780	1. 98
Nebraska	46, 190	. 90	56, 000	. 86	80, 658	1. 08	57, 481	. 83
Minnesota	24, 235	. 47	23, 700	. 36	18, 450	. 25	32, 990	. 47
Wisconsin	266, 861	5. 23	412, 614	6. 34	472, 108	6. 34	388, 726	5. 59
Michigan	88, 689	1. 73	120, 095	1. 84	132, 976	1. 77	120, 394	1. 73
Kentucky	255, 986	5. 01	318, 301	4. 89	212, 412	2. 84	256, 463	3. 69
Tennessee	50, 770	. 99	66, 897	1. 03	40, 561	. 54	42, 897	. 62
Miscellaneous	23, 447	. 65	30, 000	. 46	25, 500	. 34	24, 800	. 36
Total	5, 101, 308	100. 00	6, 505, 446	100. 00	7, 480, 648	100. 00	6, 950, 451	100. 00

The average weight per head, the average weight of lard, and the average cost per cental in the different States is shown in the following table:

States.	1876–'77. Average net weight per head.	1876–'77. Average weight of lard.	1876–'77. Average cost per cental.	1877–'78. Average net weight per head.	1877–'78. Average weight of lard.	1877–'78. Average cost per cental.
	Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	
Ohio	218. 15	36. 49	$7. 20	223. 85	39. 00	$5. 15
Indiana	199. 41	29. 69	7. 02	214. 32	34. 42	4. 93
Illinois	218. 09	35. 19	7. 42	229. 57	39. 73	5. 10
Iowa	207. 75	33. 26	6. 82	220. 53	37. 70	4. 48
Missouri	213. 93	33. 88	7. 05	219. 74	39. 12	4. 82
Kansas	240. 41	37. 16	6. 61	267. 48	42. 20	4. 36
Nebraska	220. 39	38. 10	6. 78	232. 28	47. 71	4. 40
Minnesota	249. 94	29. 30	6. 49	261. 10	44. 11	4. 42
Wisconsin	226. 67	30. 73	7. 11	236. 51	39. 14	4. 83
Michigan	232. 35	32. 90	6. 92	234. 88	36. 94	4. 83
Kentucky	222. 52	33. 10	6. 99	223. 72	34. 67	5. 35
Tennessee	208. 04	31. 48	6. 74	208. 65	31. 58	5. 03
Miscellaneous	213. 70	32. 39	7. 16	215. 33	32. 46	5. 31
Grand average	215. 92	34. 08	7. 18	226. 04	38. 61	4. 99

States.	1878–'79. Average net weight per head.	1878–'79. Average weight of lard.	1878–'79. Average cost per cental.	1879–'80. Average net weight per head.	1879–'80. Average weight of lard.	1879–'80. Average cost per cental.
	Pounds.	*Pounds.*		*Pounds.*	*Pounds.*	
Ohio	210. 47	35. 09	$3. 63	202. 11	33. 54	$5. 31
Indiana	193. 80	29. 09	3. 42	194. 90	27. 46	5. 14
Illinois	225. 71	44. 00	3. 74	223. 31	40. 37	5. 41
Iowa	211. 98	37. 73	3. 14	210. 56	36. 68	4. 87
Missouri	213. 32	40. 83	3. 40	207. 31	36. 54	4. 96
Kansas	221. 14	39. 46	3. 29	208. 00	38. 41	4. 91
Nebraska	231. 02	44. 29	3. 14	217. 88	43. 11	4. 70
Minnesota	263. 09	30. 09	2. 97	262. 22	30. 00	4. 65
Wisconsin	220. 81	36. 22	3. 47	215. 90	31. 92	5. 16
Michigan	210. 69	32. 60	3. 37	209. 25	32. 23	5. 14
Kentucky	210. 11	32. 29	3. 36	203. 89	29. 96	5. 24
Tennessee	209. 49	32. 95	3. 17	200. 30	29. 31	4. 88
Miscellaneous	205. 29	31. 37	3. 66	200. 12	30. 32	5. 43
Grand average	217. 14	39. 40	3. 56	212. 94	36. 32	5. 22

SUMMER AND WINTER PACKING CONSOLIDATED.—The following table shows the result of the last four packing seasons in the West:

Years.	Summer.	Winter.	Aggregate.	Average weight per head.	Aggregate.	Average lard per head.	Aggregate.
1876–'77	2, 357, 866	5, 101, 308	7, 459, 174	206. 01	1, 526, 357, 390	32. 79	243, 918, 870
1877–'78	2, 543, 120	6, 505, 446	9, 048, 566	216. 07	1, 955, 160, 434	37. 19	336, 557, 676
1878–'79	3, 378, 044	7,480, 648	10, 858, 692	207. 77	2, 256, 158, 991	37. 63	408, 701, 858
1879–'80	4, 051, 248	6, 950, 451	11, 001, 699	202. 11	2, 223, 594, 018	34. 72	382, 019 860

IN THE EAST.

SUMMER AND WINTER PACKING.—The following table shows the receipts of live and dressed hogs during the last three packing years, by seasons, on the Atlantic coast:

Cities.	1877-'78.			
	Summer.		Winter.	
	Live.	Dressed.	Live.	Dressed.
Boston	213, 634	9, 565	141, 933	27, 907
New York	774, 157	17, 785	636, 127	38, 229
Philadelphia	210, 750	22, 400	93, 600	37, 250
Baltimore	196, 107	5, 000	128, 916	25, 000
Total	1, 394, 648	54, 750	1, 000, 962	128, 386

Cities.	1878-'79.			
	Summer.		Winter.	
	Live.	Dressed.	Live.	Dressed.
Boston	314, 861	411	208, 848	19, 531
New York	1, 045, 332	3, 334	776, 317	53, 401
Philadelphia	215, 820	26, 342	114, 910	48, 660
Baltimore	231, 816	2, 500	140, 328	27, 500
Total	1, 807, 829	32, 587	1, 232, 403	149, 092

Cities.	1879-'80.			
	Summer.		Winter.	
	Live.	Dressed.	Live.	Dressed.
Boston	363, 423	2, 929	248, 642	19, 661
New York	1, 100, 994	10, 985	652, 590	51, 113
Philadelphia	233, 270	71, 380	108, 200	65, 276
Baltimore	229, 257	3, 000	120, 838	25, 000
Total	1, 926, 944	88, 294	1, 130, 270	161, 050

Interior cities.—The number packed in three interior cities of New York during three packing years is stated as follows:

Cities.	1876-'77.	1877-'78.	1878-'79.	1879-'80.
Albany	30, 000	15, 000	33, 353	20, 000
Troy	15, 000	15, 000	15, 000	20, 000
Buffalo	135, 250	139, 930	201, 141	237, 988
Total	180, 250	169, 930	249, 494	277, 988

ON THE PACIFIC SLOPE.

California.—It was expected, a year ago, that the supply of hogs for 1879 in California would show a decrease, compared with the previous

year, owing to the discouraging influence of low prices, but the reports furnished us indicate a slight increase in packing, and for the coming season it is expected that there will be no decrease. San Francisco continues to do the largest part of the packing, and operations are carried on throughout the year at this point. The number of hogs packed at San Francisco and the estimated number at other parts of the State was 290,000, against 280,000 last year. The number packed in Oregon is estimated as smaller than last year, and is placed at 80,000, against 120,000 in 1878.

RECAPITULATION.

The total number of hogs packed in the United States during the last four years is as follows:

Section.	1876–'77.	1877–'78.	1878–'79.	1879–'80.
The West	7,409,174	9,048,566	10,858,692	11,001,699
The East	2,551,239	2,703,670	3,222,011	3,524,546
The Pacific slope	305,000	310,000	400,000	370,000
Total	10,265,413	12,062,236	14,480,703	14,896,245

EUROPEAN STATISTICS.

The following table gives the average annual yield of wheat in the principal producing countries of the world; also, the estimated yield for the crop of 1879:

Country.	Average year.	1879.
	Bushels.	*Bushels.*
France	289,500,000	229,230,000
Russia	226,400,000	198,100,000
Germany	124,520,000	113,200,000
Spain	118,860,000	99,050,000
Italy	110,370,000	84,900,000
Austria-Hungary	104,710,000	79,240,000
Great Britain	104,000,000	59,430,000
Turkey in Europe	42,450,000	36,790,000
Roumania	33,960,000	28,300,000
Belgium	24,055,000	18,365,000
Algiers	25,470,000	21,225,000
Canada	16,980,000	16,980,000
Australia	18,395,000	22,074,000
Egypt	16,980,000	14,150,000

Among the above countries, France, Germany, and Spain, in an average year, raise sufficient for home consumption. Russia, Austria-Hungary, Turkey in Europe, Australia, Canada, Algiers, and Egypt have a surplus for export, while Great Britain usually imports nearly 100,000,000 bushels.

The agricultural returns from Great Britain and Ireland made on June 4, 1879, show a total cultivated area of 31,976,000 acres in Great Britain, 15,336,000 in Ireland, and 125,000 acres in the Isle of Man and Channel Islands. Thus for the whole of the United Kingdom the cultivated area was in 1879 47,437,000 acres, exclusive of heath and mountain pasture and of woods and plantations.

In Great Britain the area returned as under cultivation has increased by 121,000 acres since 1878, and by 264,000 acres since 1877, and the total increase since 1869 is no less than 1,637,000 acres. Of this

increase, rather more than two-thirds, or 1,134,000 acres, was in England, 228,000 in Wales, and 275,000 in Scotland.

In Ireland the cultivated area shows a decrease of 9,000 acres since a year. The decrease in 1878 was 82,000 acres, and in 1877 nearly 300,000 acres. This decrease is mainly due to much land being classed as barren mountain-land which was formerly classed as pasture.

Looking at the details of the various crops, it is seen that the area under wheat in Great Britain in 1879 was 2,890,000 acres, being a decrease of 328,000 acres from the previous year. In Ireland there was a fractional increase. The wheat crop of the United Kingdom has decreased by nearly a million of acres, or a fourth of its area, since 1869, when there was 3,982,000 acres under wheat.

Barley has partly taken the place of wheat, being this year sown on 2,932,000 acres, an increase of 209,000, or nearly 8 per cent., over 1878. Oats were sown on 3,998,000 acres in the United Kingdom, being a decrease of 126,000 acres since 1878. This crop has steadily declined since ten years. The large importations of Indian corn have doubtless competed largely with the oat crop, and, therefore, tended to diminish the breadth sown. In the green crop there is not much variation. The area planted in potatoes shows an increase of 33,000 acres in Great Britain and a slight decrease in Ireland; the total area planted was 541,344 acres in Great Britain and 842,621 in Ireland.

In live stock there has been an increase of horses and cattle and a decrease in sheep and swine. The total numbers for the United Kingdom are, horses, 1,955,394; cattle, 9,961,536; sheep, 32,237,958; swine, 3,178,106. Swine have decreased in number in Great Britain nearly 16 per cent. since 1878. In Ireland the same proportionate reduction has taken place; the competition of American bacon is the main cause.

AUSTRALIA.

From the returns of Australia it appears that rather more than 2,500,000 acres of land are sown in wheat, being twice the area sown eight years ago. The average yield was about ten bushels per acre; the largest wheat growing district (South Australia) has an average of little more than seven bushels per acre, while New Zealand averaged nearly 23 bushels, and New South Wales 14¾ bushels per acre. Oats were grown on 467,000 acres and averaged 25 bushels per acre. Indian corn is only grown to any extent in New South Wales, and was 186,000 acres in area and yielded 32 bushels per acre. Potatoes were planted on 88,000 acres and averaged a yield per acre of 112 bushels; in New Zealand the yield averaged 170 bushels per acre. In live stock there are in Australia rather more than a million of horses, 7,250,000 cattle, and 61,000,000 sheep.

FRANCE.

In France the acreage sown in wheat was, within a small fraction, the same as in 1878, viz, 17,200,000 acres. The yield per acre was less than the poor yield of last year, and is estimated at a fraction above 13 bushels per acre. The total crop is estimated at 229,000,000 bushels for 1879; the crop in an average year is 289,500,000 bushels, consequently the crop of 1879 falls short of an average 60,500,000 bushels, or nearly 21 per cent.

From the Bulletin Statistique it appears that the area planted in vineyards in France was greatest in 1874, when it amounted to 6,046,820 acres, a surface equal to one-fourth of the State of Ohio. There was a gradual decline in the area, caused by disease, till in 1878 it was

5,200,000 acres. The crop of 1878 was stated at 1,286,546,000 gallons, being a decline of 202,944,000 gallons from the year previous, and a decline of 213,799,000 gallons from the average of the ten previous years. This growing deficit was attributed to the appearance of the phylloxera and reappearance of the oidium. For the year 1879, in the absence of official returns, it was estimated by L'Economist Français that 988,000 acres had been destroyed and 466,000 acres seriously injured by the phylloxera. The crop was subjected to the most unfavorable atmospheric conditions, which, with the ravages of the phylloxera and oidium, gave a return of only 678,994,000 gallons, a decline of nearly one-half from the crop of 1878, and only one-third the amount for 1874.

AVERAGE YIELD PER ACRE.

The following estimates of the average yield per acre of principal crops were published by the international statistical congress in France a few years since:

Country.	Wheat.	Rye.	Barley.	Oats.	Corn.	Buckwheat.	Potatoes.	Tobacco.
	Bush.	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Bush.*	*Lbs.*
Great Britain	29.9	34.5	39.	45.9	....	....	165.4	....
Austria	15.6	15.2	17.5	19.8	15.6	13.9	84.2	....
Hungary	12.6	18.6	14.5	14.2	17.1	10.3	137.8	677
Prussia	17.6	17.2	25.8	33.9	....	....	....	....
Bavaria	20.2	16.9	20.9	33.2	25.7	12.4	105.	1,480
Belgium	27.9	25.4	35.1	42.5	....	24.9	191.	1,177
France	17.1	15.8	20.8	25.4	18.4	19.4	128.	972
Spain	16.1	....	18.4	....	16.1	....	126.	....

SUGAR CROP OF THE WORLD.

It is estimated that the supply of sugar for the world is about 5,000,000 tons. This estimate, of course, does not include the unknown quantity of China, which exports 25,000 tons annually, nor of similar countries inaccessible to investigation; it does, however, include British India, which, although a non-exporting country, produces for home consumption 1,450,000 tons annually. The following estimate of the crops of the years 1878 and 1879 gives the quantity produced in all the principal sugar-producing and exporting countries:

BEET-ROOT SUGAR.

Country.	1879–'80.	1878–'79.
France ....tons..	290,000	432,000
Germany ....do...	390,000	428,000
Austria-Hungary ....do...	360,000	405,000
Russia-Poland ....do...	215,000	215,000
Belgium ....do...	55,000	70,500
Netherlands and others ....do...	25,000	30,000
Total	1,335,000	1,572,500

CANE SUGAR.

Country.	1879–'80.	1878–'79.
Cuba ....tons...	625,000	645,000
Porto Rico ....do....	90,000	90,000
Jamaica-Hayti ....do....	25,000	25,000
Martinique ....do....	40,000	40,000
Guadaloupe ....do....	50,000	50,000
Trinidad ....do....	55,000	57,000
Barbadoes ....do....	50,000	54,000
Demerara ....do....	60,000	60,000
Brazil (exports) ....do....	140,000	101,000
Peru (exports) ....do....	80,000	85,000
Java (exports) ....do....	180,000	215,000
Manila (exports) ....do....	120,000	120,000
Australia (exports) ....do....	20,000	20,000
Sandwich Islands (exports) ....do....	12,000	12,000
NON-EXPORTING COUNTRIES.		
Spain ....tons...	15,000	15,000
Cochin China ....do....	25,000	25,000
Japan ....do....	15,000	15,000
Mexico ....do....	30,000	30,000
English India ....do....	1,450,000	1,450,000
Egypt (produces) ....do....	50,000	30,000
Total cane sugar	3,132,000	3,139,000
Total beet sugar	1,355,000	1,572,500
Grand total	4,487,000	4,721,500

The United States produces 110,000 tons, of which Louisiana contributes 100,000.

CONCLUSION.

In conclusion I would remark that in addition to the monthly report on the condition of crops made by this division there have been many investigations and compilations made for members of Congress, agricultural societies, and boards of trade, which, although of a public character and value, are not published, for want of space, in this report.

CHARLES WORTHINGTON,
Statistician.

Hon. W. G. LeDuc,
Commissioner,

REPORT OF THE ENTOMOLOGIST.

Sir: I have the honor to submit the following report of a part of the investigations carried on by the Entomological Division of the Department of Agriculture during the past year. These researches have been briefly as follows: The completing of the investigation of insects injurious to the cotton-plant, which was begun in 1878; the beginning of an examination of insects injurious to orange trees; and a study of various other insects of economic importance which have been brought to the attention of the Department.

The work of this year on the cotton-insect investigation consisted of clearing up some obscure points in the life history of the cotton-worm and boll-worm, the conducting of an extensive series of experiments with remedies, and the writing of a report upon the whole investigation, which has been published.

Much information has been gained respecting insects injurious to orange trees. Accounts of a few of these insects are included in the following report. But I am able to present at this time only a small part of the data which I have collected on this subject, owing to lack of time for preparing the remainder for the press.

Accounts of many other insects which have been studied during the year are not included in this report, as in many instances it is desirable that further observations be made before publishing the results obtained.

Believing that the work of this Division should be of a practical nature, I have, in my investigations, confined myself as far as possible to the study of the habits of insects and to experiments with remedies. However, for the sake of scientific accuracy, it is necessary that the exact zoölogical position of the species described should be indicated, and that the new species should be characterized in a technical manner. This is a work which can be well done only by one who devotes his exclusive attention to the systematic study of the particular group of insects to which the species in question belongs. I have therefore invited the aid of specialists in work of this nature; and in every case the assistance has been promptly and cheerfully rendered, and without pecuniary recompense.

In this connection I wish to acknowledge the aid of the following-named gentlemen: Mr. Edward Burgess, for determinations and descriptions of Diptera; Mr. V. T. Chambers, for determinations and descriptions of Tineids; Mr. E. T. Cresson, for determinations and descriptions of Ichneumon flies; Prof. C. H. Fernald, for determinations and descriptions of Tortricids; Mr. A. R. Grote, for determinations of Noctuids; Dr. George Horn and Mr. Henry Ulke, for determinations of Coleoptera; Mr. L. O. Howard, for description of a Chalcid; Mr. J. Monell, for description of an Aphid; Mr. Edward Norton, for description of a Saw-fly, and Dr. P. R. Uhler for determinations and descriptions of Hemiptera.

The correspondence of the Division has continued to increase during the past year. Very many inquiries respecting noxious insects and the means of preventing their ravages have been received from all parts of the country. This correspondence has occupied much of my own time and all that of an assistant. A large part of these inquiries were respecting well-known insects, and I trust that in many instances information has been given which has materially aided our correspondents in combating the pests. In other cases the insects have proven to be new to science, or species whose habits were unknown. In this way many interesting and important subjects for study have been presented.

Large additions have been made to the biological collection of the Division, among which may be mentioned over 1,600 slides of microscopical insects and about 40 cases of larger specimens.

I take pleasure in acknowledging the assistance of Mr. L. O. Howard in the preparation of this report, and in the general work of the Division; also the aid of Mr. Th. Pergande in the care of the insects bred in my office, and in making biological notes upon them. The original figures illustrating this report have been drawn from nature by Mr. George Marx.

Respectfully submitted June 30, 1880.

J. HENRY COMSTOCK,
Entomologist.

Hon. WILLIAM G. LE DUC,
Commissioner of Agriculture.

THE ARMY-WORM.

(*Heliophila* (*Leucania*) *unipuncta* Haworth.)

Order LEPIDOPTERA; family NOCTUIDAE.

Eating the leaves and heads of the different grasses and cereals, a worm 1½ inches long, longitudinally striped with black, yellow, and green, appearing in immense numbers, and keeping together in a more or less compact body when advancing from one field to another.

Recent inquiries from many sections of the country concerning this celebrated pest have called to our attention the fact that, although it has been thoroughly discussed by several State entomologists, the reports of the Department of Agriculture have never contained more than a mere passing notice of its injuries. Since the writings of the authors referred to are accessible to but few farmers residing outside of the States which published them, it seems advisable to introduce here a review of the present knowledge concerning this insect.*

As to the past history of the army-worm, it will suffice to state briefly that it has been known in this country since 1743; that it is impossible to say whether it is an indigene or whether it has been introduced from Europe; that it is known in almost every part of the world; and that its natural history first began to be studied in this country after the great army-worm year of 1861.

The adult insect is a night-flying moth of a dull brown color, marked in the center of each forewing with a distinct white spot, and with an expanse of wing of about 45^{mm} (a little over an inch and three-quarters). Fig. 2.

The egg is white and almost spherical. Its average is .6^{mm} (.023 inch). The perfect outline is sometimes lost from the gummy substance which covers it and which holds it in place. The moth deposits her eggs in the folds of grass or grain, always concealing them from sight by pushing them down into the unfolded portion of the leaf, or by cementing the edges of the leaf together over them. Sometimes, however, they are laid in a partial fold and remain perfectly exposed to view. (Pl. I, fig. 1.) The eggs are laid singly or in rows which sometimes contain as many as fifteen or twenty.

The larva, or worm, when full grown, is 38^{mm} (1½ inch) in length. (Pl. I, fig. 3.) During this stage—which lasts from fifteen to thirty days—the worm casts its skin five times. Its body color is pale green, clearly seen only on the ventral surface, varied elsewhere with longitudinal stripes of yellow, gray, and black, the gray often so closely dotted with black as to become dusky. The general arrangement of the stripes is as follows: The entire back is occupied by a broad black or dusky band, deepest at the middle and along each margin. On each flank is a series of stripes, consisting of a median black or dusky band, on each side of which is a greenish or yellow stripe of equal width, margined on either hand with dingy white that is set off by a mere line of dark. Down the middle of the back is an interrupted narrow white line, often clearly seen only near the head.

* The best articles which have been written concerning its life history are those of Fitch (Sixth N. Y. Rept., p. 113), Riley (Eighth Missouri Rept., p. 22), and Packard (Report on the Rocky Mountain Locust and other Insects now injuring or likely to injure field and garden crops. From the Ninth Ann. Rept. U. S. Geol. & Geog. Surv. of Terr.).

The habits of the worms are somewhat like those of their relatives, the cut-worms, in that they feed chiefly at night. During the heat of the day they hide under sticks, stones, or other rubbish, though, when occurring in great numbers, they often eat during the entire day or disappear only for a few hours. When migrating from an eaten field to a new one they have the habit of going together and nearly always in the same direction, which has given them their popular name of "army-worm." Their food plants are naturally the grasses and grains. During the present season they have usually appeared first in fields of wheat, occasionally in timothy and blue grass, seldom in any other cultivated crop. When on the march they attack preferably the cereals, timothy, blue grass, and corn. Many other plants are eaten to a small extent. Shortly after the last moult the worm burrows just beneath the surface of the ground, and transforms to a pupa in the cell thus formed.

The pupa is dark brown in color and is from 18 to 20^{mm} (three-quarters of an inch) in length. Its shape is shown in Pl. I, fig. 1.

The number of generations in a season varies greatly with the climate. It has always been supposed that there is but one in the Northern States, but there will probably be two on Long Island this year, as moths are now (June 21, 1880) emerging from pupae collected there a few days ago. Professors Thomas and French state that there are normally two broods in Northern Illinois, and probably three in the more southern portions of that State. Professor Riley has demonstrated two broods normally and three broods exceptionally in the latitude of Saint Louis. Farther south, during winters of unusual mildness, a succession of broods is kept up through the entire year. During the present winter (1879–'80) we have received full-grown worms with accounts of damage to winter grain in the months of December, January, and February from localities as far north as Union County, South Carolina, and Marion County, Tennessee. Ordinarily, however, in these States, and always farther north, the insect lies dormant through the winter months.

Concerning the hibernation of the army worm writers have long differed. We can now safely state that it hibernates both in the moth and chrysalis states, the former being more common in the southern part of the country and the latter in the northern regions.* There is also a possi-

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* Since the days of Walsh, no one has strongly upheld the probability of an extensive hibernation of the eggs. We may briefly state the arguments which have been advanced in favor of hibernation in each stage as follows:

Egg hibernation.—In fields which have been burned over in fall or winter the worm does not appear the following year. (Many cases cited by Walsh and Riley.) Walsh (Prairie Farmer, 1861) states an instance where one-half of an infested field was burned over and the other half not. The succeeding year the burned half was free from worms and the other was infested. Against this argument Thomas (*Ibid.*) urges that the moths appear in early spring and oviposit on old grass stubs before the young grass has grown; naturally, therefore, where the old grass has been destroyed they will not lay their eggs. Riley cites the Wisconsin fires of 1871, which occurred in October, notwithstanding which the worms were very abundant the succeeding year in the same localities.

Larval hibernation.—All European species of *Leucania*, so far as known, hibernate as larvae. Many allied cut-worms hibernate in this state. Against such hibernation Riley urges that, instead of wet springs being favorable to increase (as has been supposed to be the case), were there an extensive larval hibernation such weather would be the most unfavorable, as the overflowing of swamp land would drown them.

Pupal hibernation.—Moths are found in early spring in such fresh condition, with wings so soft that they have evidently just emerged from their pupal cases. Mr. Meske, of Albany, N. Y., once found a chrysalis in May, from which a true army-worm moth issued, the date being so early as to preclude the possibility of a brood having already been generated. Professor Riley urges the instance of the Wisconsin fires in favor of this method of hibernation. Many allied *Noctuids* are known to hibernate in this form.

bility that the full-grown worms hibernate more or less frequently. In either case, as soon as the weather becomes warm in spring the moths emerge either from their pupal cases or their hibernating quarters, and lay their eggs as before described. The duration of the egg state is from eight to ten days. We found the newly hatched larvae in Washington on the 13th of May, 1879.

The natural habitat of the army worm was stated by Dr. Fitch to be "in the wild grass of wet spots, in swamps and on the border of marshes," and in this statement he has been followed by nearly all succeeding writers. The question then naturally arises, What is the cause of these sudden and extensive periodical visitations to cultivated crops? Dr. Fitch observed that the year 1861 was very wet, while that of 1860 had been extremely dry. On examining the records he found that in previous worm years the season in which the worms appeared was wet, while the preceding year was dry. He therefore proposed the theory that in a dry season this insect, having an unlimited extent of feeding range, becomes greatly multiplied, "and when it is thus multiplied, a wet season and overflowed swamps drive it out from its lurking place, in flocks, alighting here and there over the country. But on being thus rusticated, it finds our arable lands too dry for it, and immediately on maturing and getting its wings again it flies back to the swamps, whereby it happens that we see no more of it." Professor Riley adopted this theory, and showed that the conditions in 1869 and 1875 (two marked army worm years) coincided with those mentioned by Fitch.

HOW TO DESTROY THE PEST.

Remedies.—If the theory just quoted be true, the best means of preventing the occurrence of this pest in cultivated fields will be to keep watch of any extensive tracts of low land which may be in the neighborhood, and if army worms are discovered destroy them either by burning over the land, if possible, or by poisoning with arsenic, Paris green, or London purple, or by any other means of which the local conditions will admit. In fact it would be well to burn over all the low land in the vicinity each winter, thus destroying the hibernating insects.

I do not feel implicit confidence, however, in the above theory, as I have observed the army worms feeding in small numbers in meadows on high lands, when their presence there could not be explained by the reasons given. Moreover, from what data I have been able to obtain while preparing this article, it appears that the present season has not been a wet one in those localities in which the army worm has appeared, thus failing to confirm the theory. It is worthy of note, however, that in most instances the localities infested by the worm this year are in the vicinity of extensive tracts of low lands. I am carefully collecting evidence on these points and will publish the results as soon as practicable.

In case the worms do appear in cultivated lands the best plan of action to follow is to prevent the spreading of the insect. This may be done by destroying them or by confining them to the fields in which they appear. The best methods of destroying them are by crushing with rollers or by poisoning with arsenic, Paris green, or London purple. Either of these substances can be applied rapidly by mixing with water and

Hibernation as moths.—Of this there can be no doubt. Specimens have been received at this department from Texas, Alabama, and Georgia all through the winter. "Some specimens captured in the spring in Southern Illinois have a battered and weather-worn appearance." (French.) Mr. Strecker has found the moth hibernating in February at Reading, Pa., and Mr. Mann has also found it at Cambridge, Mass.

using a fountain pump or garden syringe. In many instances, however, these remedies are impracticable, for frequently the worms appear in a field of grain so late in the season that the crop is only partially destroyed. In some instances only the leaves and beards of the grain are eaten by the worms, the straw and heads being too mature to be relished by them. In such cases the destruction of the crop by the use of rollers or poisons would be an expensive method of fighting the pest. And, too, the use of rollers often proves less effectual than would be expected. If the soil be rough it is obvious that many worms would escape; and it was found by experiment on Long Island this year that even when the surface was level the rollers became partially covered with masses of tenacious mud, composed of earth and the juices of the crushed worms, so that the effect was much the same as though the ground had been uneven.

When these remedies prove impracticable the second line of defense remains, and if well carried out the result will not merely be the confining of the worms to the fields in which they appear, but the destruction of them also when they attempt to migrate to other fields. This is done by the means of ditches and pits dug around the infested field or that to be protected. The ditches can be made quite rapidly. First plow a furrow with the "land side" next to the field to be protected, and then with a spade make this side of the furrow vertical, or, if the soil be compact enough to admit of it, overhanging. When the ditch is completed, holes should be dug in it from 1 foot to 18 inches deep and from 20 to 30 feet apart. The sides of these holes should also be vertical, or, if possible, overhanging. The worms, unable to climb up the vertical side of the ditch, will crawl along the bottom of it and fall into the holes, where they will soon perish. Where the soil is sandy, so that the ditch cannot be made with a vertical side, it should be dug deeper than in other cases, and the side made as nearly perpendicular as possible, so that when the worms attempt to crawl up it the sand will crumble beneath them and cause them to fall back again. The soil can be kept friable by drawing a bundle of brush along the ditch, or by burning straw in it.

The degree of success and the amount of labor attending the use of this method of defense depend upon the promptness with which it is adopted. If a close watch be kept of the grain fields and meadows during late spring and early summer, the presence of the worms can be detected before they begin to migrate. It will then be only necessary to inclose, by means of ditches, those parts of the fields in which the worms are found; and frequently these localities are very limited. But if the work be delayed until later in the season, after the worms have begun to migrate, it will be found difficult to confine them, and it will probably be necessary instead of this to surround by ditches the fields to be protected, especially any fields of corn that may be in the vicinity of the infested district.

Numerous other remedies have been proposed, but we know of none which are practicable, except on a small scale or under especially favorable conditions.

The parasites of the army worm are very numerous, and benefit the farmer to an almost incalculable extent. By far the most abundant is the red-tailed Tachina fly (*Nemoraea leucaniae*, Kirkp.). This insect, shown at Pl. I, fig. 2, has much the appearance of the ordinary house-fly, and is usually found in immense numbers wherever the army worm abounds. The natural but interesting mistake has been made by some of our correspondents of considering the red-tailed Tachina as the progenitor of the army worm. The eggs of this Tachina are white,

oval, and smooth, and are usually laid upon the anterior part of the worm. Occasionally as many as eighteen eggs are laid on a single worm, but the average number is about five. These eggs are so ingeniously placed that the worm can by no possibility reach them with its jaws or get rid of them in any other way. Mr. Howard says that he has searched for hours in a field infested with army worms without finding a single full-grown worm which did not carry one or more of these eggs upon its back. The general habits of the Tachina flies have been given under the head of the parasites on the cotton worm, and further elaboration will be unnecessary. The abundance of this and other parasites partially explains the periodicity of the army-worm attacks.

Another Tachina (*Exorista flavicauda*), similar to the red-tail, has been described by Riley. Walsh described three species of hymenopterous parasites upon the army worm: the Military Microgaster (*Microgaster militaris*), the Glassy Mesochorus (*Mesochorus vitreus*), and the Diminished Pezomachus (*Pezomachus minimus*). *Ophion purgatus*, a large ichneumon, was reared from the army worm by Mr. Shurtleff, and Dr. Fitch describes another species as *Ichneumon leucaniae.*

In addition to these true parasites, the army worm is attacked by many predaceous insects and by insectivorous birds. We have noticed, moreover, many specimens covered with a mite similar to *Uropoda americana*, which has proved so destructive to the Colorado potato beetle. The following-named ground beetles are commonly found preying on the army worm: *Calosoma calidum*, *C. scrutator*, *Harpalus caliginosus*, and *Pasimachus elongatus*. The first three of these are figured further on as enemies of the cotton worm. Ants are also very efficient enemies of the army worm.

THE DESTRUCTIVE LEAF HOPPER.

Cicadula exitiosa Uhler [new species].

Order HOMOPTERA, family TETTIGONIDAE.

Puncturing the bases of the outer leaves of winter wheat, causing them to turn yellow and die, a small, active, flying and jumping brownish leaf hopper, occasionally appearing in immense numbers.

During the past winter much damage has been done to the winter grain in Western South Carolina and in the borders of the surrounding States by the above-named insect. Reports from Mecklenburgh County, North Carolina, York, Abbeville, Union, and Laurens Counties, South Carolina, and Catoosa County, Georgia, state that these leaf-hoppers appeared in immense numbers and did great injury to the crops.

This appearance, although phenomenal, was not unprecedented. Insects of the same sub-family (*Jassidae*) have long been injurious to the wheat crop in parts of Europe. In this country an allied species was reported in the spring of 1875 as doing much damage to the meadows of certain parts of Illinois, and during the winter of 1876 the winter grain in parts of Texas is said to have been much injured by one or more species of Jassid. The species under consideration was identified by Professor Uhler, who has collected specimens of it in various parts of Maryland and at Denver, Col., and has received specimens collected in Texas, Florida, and North Carolina.

The destructive leaf-hopper is a small active brownish flying insect, measuring with its wings folded about 5^{mm} (.195 inch) in length. Its general shape is well indicated by figure 4, Pl. I. It is very quick, a good flyer, and a great jumper.

So many alarming reports were received during the course of the winter as to the extent of damage, that it was deemed necessary for me to visit the infested locality, which was accordingly done on my return from Florida about the first of March. In company with Mr. C. R. Jones, of the Charlotte *Observer*, I inspected several fields in the vicinity of Charlotte, North Carolina, and found that the accounts had not been exaggerated. In one infested field of 10 acres, belonging to Mr. Geo. King, there was hardly one plant left to each square rod of ground. The diseased appearance most common in the wheat fields was a wilting of the outer leaves of the plant. Professor Uhler informs me that the customary method of injuring grass or grain is to pierce and suck the juices from the midrib of the leaf, and this method of work I have been able to confirm by an examination of leaves taken from the infested wheat. In a few cases I found the wilted leaves nearly cut off at the base; this must have been done by some other insect.

In the wheat fields of Mr. W. W. Rankin the leaf-hoppers were at work in large numbers. There was observable on this plantation a most exact line between the eaten and the uneaten portions. Instead of spreading themselves indiscriminately over the field, or half eating a patch here and there, they ate the wheat down to the ground as they progressed. In an eight-acre field six and one-half acres were utterly destroyed, while on the remaining acre and a half the crop was almost uninjured. It was, however, being rapidly destroyed. Here was apparently a good opportunity to watch them at their work, but it was impossible to do much on account of their extreme shyness, as they would fly upon the least disturbance. Professor Uhler has observed them about the time of oviposition resting on the midrib of a blade of grass or grain, with the head pointed towards the base of the leaf. The eggs are usually laid in the stems of grasses near the ground, judging from the known habits of allied species. The young hoppers when hatched are of almost precisely the same appearance as the old ones, except that they lack the wings. The time occupied in attaining full growth probably does not exceed a month, so that there are several broods a year.

Many erroneous opinions were given concerning the nature of this insect. Many considered it to be some form of the Hessian fly. Others, without attempting to name it, called it the fly of the maggot, which lives near the roots of the wheat. I was also informed by Mr. Jones that a theory was prevalent to the effect that the leaf-hoppers had spread from the cotton fields from the fact that similar insects were found in the dried cotton bolls. An examination, however, showed the cotton-boll insects to be a *Psocus*, often found in such situations, and which belongs to an entirely different Order from the leaf-hoppers, the *Neuroptera*.

The great damage done the past winter was probably a result of the extreme mildness of the weather. Under ordinary circumstances the leaf-hoppers are kept in winter quarters and many are killed by cold weather. The present winter has been so warm, however, that they have been able to feed and reproduce continually. Moreover, the crops being in a young and tender condition, the effect of the work of the hoppers was infinitely more marked than it could ever be at any other season of the year. Under the ordinary conditions, then, of a moderately cold winter the ravages of this pest are not to be feared.

From our present knowledge of the habits of the leaf-hoppers, their injuries in mild winters in the more southern portions of the wheat belt will be very difficult to control. The only remedy which I have been

able to suggest in answer to the urgent inquiries of the South Carolina farmers has been that used for the destruction of the allied leaf-hoppers on the grape vine, namely, carrying lighted torches through the infested fields at night, or building bonfires at different points. These insects are readily attracted by light, and great numbers will without doubt be destroyed. One or another of the trap lanterns mentioned in that part of this report relating to the cotton worm could without much doubt be used to advantage if a number were mounted on posts in different parts of the fields.

A green leaf-hopper somewhat larger in size has recently been received from Laurens, S. C., with an account of its injuries similar to those given of the destructive leaf-hopper. It was identified by Professor Uhler as the *Diedrocephala flaviceps* of Riley, a species which did much injury to grain in Texas in 1876.

DESCRIPTIVE.

CICADULA EXITIOSA Uhler (n. sp.).

Long subfusiform, ground color pale testaceous, polished above, but dull beneath; the upper surface of the abdomen black, excepting the lateral and hind margins of the segments. Face yellow, crossed on each side by a series of slender, brown, curved lines, the outer cheeks with two long brown spots, and the forehead with a roundish, black spot each side of the middle, exterior to which the reddish-brown ocelli are seen next the suture, and below the latter is a small, brown spot of about their size; in the middle is usually a small brown dot. The vertex is arcuated; with the tip a little angular, the surface on the posterior half transversely depressed, and marked with a curved, brown, transverse cloud, which has two blackish dots just behind it, a small spot near each outer angle, and a slender streak along the middle: any one, or several, of these are sometimes absent. Pronotum with a whitish line in the middle and a short oblique one each side; anteriorly is a strongly curved series of longish brown dots, and on the posterior half occasionally a few obscure, cloudy marks. Scutellum with a pale line on the middle running through a brown spot, or only a faint cloud instead; each side, basally, with a whitish oblique line, and near each basal angle is a deltoid brown mark or line. Hemelytra translucent, or faintly tinged with brown, narrow, moderately valvate; the costal nervule pale, moderately curved; the other nervules brown; those of the clavis and its margins very much thickened, and sometimes tinged around with brownish cloudings. A few specimens show pale interruptions near the middle of the discoidal nervules. Wings milky or almost transparent whitish. Legs pale yellow, with the knees and tarsi occasionally brownish. Sternum and base of venter black.

Length of body, $3\frac{1}{4}$–$4\frac{1}{2}^{mm}$; to tip of wings, $4\frac{1}{4}$–$5\frac{1}{4}^{mm}$; width of pronotum, $1\frac{1}{2}$–$1\frac{3}{4}^{mm}$.

This description was furnished to the American Entomologist at the same time that it was sent for publication in this report, and appeared in No. 3, Vol. III, of that journal. The species then dates from the publication of that number rather than from the time of publication of this report.

THE CLOVER-SEED MIDGE.

(*Cecidomyia legumenicola* Lintner.)

Order DIPTERA, family CECIDOMYIDAE.

ADDITIONAL FACTS CONCERNING ITS NATURAL HISTORY.

Eating out the contents of the seed vessel of red and white clover, and afterwards dropping to the ground to transform, a minute oval, orange-colored maggot.

In the last annual report of this department, Professor Riley, then entomologist, made mention of the extensive injuries of this insect in various parts of New York State, and gave a short review of the facts which were known concerning its natural history, accompanying it with illustrations of the larva and adult. Mr. Lintner, in the Canadian Entomologist for July, 1879, gave a few additional facts on classification and geographical distribution. The manner in which the former article

has been copied far and wide by the agricultural press sufficiently indicates the general interest taken in this important insect. The studies of the past season have resulted in the discovery of several new facts of interest, which we here give.

Geographical distribution.—The midge has been reported from nearly every section of New York State, and Mr. Lintner has collected specimens on Mount Equinox, Vermont. It will undoubtedly be found in all the neighboring States. During the past summer clover in the District of Columbia and across the river in Virginia has been sadly damaged by this insect, and specimens were collected in the southern part of the State close to the North Carolina border-line, in the latter part of May, by Mr. Howard.

Food plants.—In addition to destroying the seed of the red clover (*Trifolium pratense*) the larvae of *C. leguminicola* have been found in considerable numbers in the heads of the common white clover (*T. repens*) upon the department grounds in Washington.

The eggs.—No observations have heretofore been made upon the eggs of this insect, the last report of this department simply containing the conjecture that they would prove similar to those of the Hessian fly and wheat midge. During the month of September last the midges were observed copulating and the females afterwards laying their eggs. The eggs are so small that it is almost impossible to see them with the naked eye. Their average length is .27^{mm} (.01 inch.) They are a long oval in shape, their length being three times their breadth, and one end is slightly larger than the other. The general color is pale yellow, and an orange streak is more or less evident, according to the age of the embryo. The chorion is transparent and polished.

The female in depositing her eggs simply pushes them down between the hairs which surround the seed capsule of the yet undeveloped florets. They do not appear to be glued to the hairs nor are they inserted into the skin of the capsule, and I have never seen them pushed into the closed florets. After the larvae hatch, they have to work their way to the seed through the mouth of the flower. The eggs are usually laid singly, but are often found in clusters of from two to five. In one flower-head I have counted over fifty eggs.

The larvae; variation in color.—The specimens of the seed maggots received last year from Yates County, New York, were bright orange-red in color, while those found this spring in Washington were nearly white, occasionally with a tinge of pinkish. Specimens received about the middle of the summer from Otsego and Schoharie Counties, New York, were also nearly white in color, while specimens from Yates County had still the strong orange tinge.

As stated in the report for 1878, the full-grown larvae leave the clover heads and fall to the ground where they form for themselves small cocoons. As they leave the heads of clover, the sight is an interesting one. A head, which one moment is motionless, and at a glance seems to have no animal life about it, becomes, the next, fairly swarming with these maggots. From nearly every closed floret one emerges and wriggles violently, until it works its way so far that it falls to the ground. A patch of clover, which was observed by Mr. Howard, on the morning of May 23 last, seemed entirely alive with the issuing maggots and their accompanying parasitic foes.

The pupa.—No description has as yet been given of the pupa of this insect, probably owing to the difficulty of removing it from its cocoon. The pupa is pale orange in color, with brown eyes. On the front of the head are two short conical tubercles, and behind them two long bristles.

The leg sheaths reach nearly to the end of the abdomen, the wing-pads to the 4th abdominal segment, and the antennal sheaths to the 1st abdominal segment. From each side of the mesothorax, just anterior and ventral to the insertion of the wings, projects a rather long excurved horn. After the fly has emerged, if the pupal skin be examined, the antennal sheaths will be found curved out like the handles to an urn, giving it a peculiar appearance. The duration of the pupa state of the early brood is about ten days.

The adult insect; variations.—The midges vary to a greater or less extent in size, color, and markings. Some are much smaller, and paler in color than others. The males, in which the variation is most noticeable, have a double row of transverse dark spots on the dorsum of the abdomen. These spots are in some individuals almost entirely absent, and in others they vary much in size and distinctness. On the ventral side of the abdomen there is also a central row of irregularly shaped dark spots, in which there is also much variation.

Number of broods.—There are certainly two and possibly three broods in a season in New York. Mr. Lintner states that the flies begin making their appearance the latter part of May. From earth from a clover field in Geneva, N. Y., the flies issued from the 3d to the 27th of June. He also records larvae in Vermont on July 1, and in Albany on July 5. Clover full of larvae was received from Otsego and Schoharie Counties, New York, on July 2. July 18 and August 12 clover heads full of larvae were received from Yates County. The first flies from the specimens from Otsego and Schoharie Counties issued August 26; and September 10 the flies from the Yates County larvae commenced to issue. In Washington three broods in a season seems to be the rule. The full-grown larvae of the first brood were found going into the ground in great numbers on the 23d of May. The first flies issued on June 7, and early in September they were again issuing in large numbers.

Remedies.—No remedies have been proposed except that Professor Riley says: "If the injuries of this insect should become serious, the clover-seed raiser will be obliged to abandon for a series of years the growth of this crop, as in no other way are we likely to be able to affect the multiplication of the enemy." We hardly think, however, that the case will prove as desperate as this. In New York State it is the custom to cut clover twice in the season; once from June 20 to July 10, when the clover is in full bloom, for hay alone, and again in the latter part of September, or from that time till the 1st of November, depending upon the time of cutting the first crop, for seed. Now, as we have shown under the head of number of broods, the great majority of the first brood of maggots attain their full growth about the latter part of June, and leave the heads to go into the ground to transform. From this fact we readily draw the conclusion that were the first crop of clover cut in *early* June the bulk of the first brood would be destroyed, and at the expense of a slight reduction in his crop of hay the farmer would enormously increase the prospects of his crop of seed. The more universally this is practiced, the better of course will be the results to each, and care should be taken to cut at the same time any clover that may be growing wild in fence corners, by road sides, or elsewhere. The time for cutting in order to destroy the most larvae will, of course, vary with the locality and also with the character of the season, whether cold or warm; hence the importance of the farmer making himself perfectly familiar with the midge in all its forms, with its manner of work, and of keeping a sharp lookout during late spring for the first larvae. If this remedy is thoroughly tried we feel sure it will be the means of reducing the numbers of the midges.

PARASITES ON THE CLOVER-SEED MIDGE.

The first of these parasites belongs to the same subfamily (*Eurytomidae*) of the Chalcididae as does the celebrated joint worm fly (*Isosoma hordei*). It was placed in Mr. Howard's hands, and by him determined to be a new species of the genus *Eurytoma*. He submits the following:

GENERIC CHARACTERS.—Insects of small size and compact form. Head of moderate size; antennae with females short and nearly naked; of 10 or 11 joints; with males longer and with whorls of hair. Collar very prominent and nearly quadrate. Top of head and thorax strongly punctured. Abdomen smooth and shining; with the ♀ slightly compressed laterally, and of an irregular oval shape, scarcely pedunculate, very sharp at tip: with the ♂ rounder, smaller, and with a stout and quite long peduncle. Legs rather slender; middle and hind tibiae with small spines at tip; hind tibiae without rows of bristles. Subcostal vein strong, and reaching the costa at or slightly before the middle of the wing, continues for a very short distance or not at all along costa before giving off stigma, which is straight, short, and somewhat clubbed at the tip, usually with slight indications of a short branch.

EURYTOMA FUNEBRIS n. sp. *Male.*—Length of body, 1.7mm., expanse of wings, 2.5mm. Head slightly wider than thorax; antennae nearly as long as thorax; flagellum of antennae 6-jointed (counting the club as 1 joint); joints very strongly incised from above, subequal in length except club and first joint; each joint, except club, with two whorls of yellowish hair, each whorl as long as the joint. Top of head and thorax coarsely punctured, and covered with sparse and very short whitish hair. Subcostal vein yellowish and strong, reaches costa a little before the middle of the wing, and almost immediately gives off stigma: stigma with a small club and faint indication of a branch. Peduncle very strong and not long: abdomen very small, less than half the length of the thorax. General color black, eyes dark brown, knees, anterior tibiae, all tarsi light brown. 7 specimens. *Female.*—Length of body, 1.9mm., expanse of wings, 2.7mm. Antennae shorter than in ♂, and joints much more closely united: no hairs; flagellum 7-jointed, the club larger in proportion than in the ♂. Abdomen longer than thorax, not pedunculated: ovipositor slightly extruded, light brown in color: [illegible] specimens.

This species comes very near to the European *E. gibba*, Boh., but we deem it altogether likely that it will stand as a distinct species.

Parasitic upon the clover-seed midge (*Cecidomyia leguminicola* Lintner): working upon the larva while in the clover-seed capsule, undergoing all of its transformations within the seed vessel, and making its exit as an adult through a round hole cut in the side. May and June, D. C.

The first specimens of this parasite were found upon the 3d of May, and from that date until the end of June they were very abundant. As stated above, they undergo their transformations within the seed, and as flies gnaw an irregular hole through the seed vessel just large enough to let them out at or shortly after the time when the maggots have left the seed to go into the ground. The examination of many seed heads on the 20th of June showed the fact that, on an average, five-sixths of the seed had been destroyed by the midges, and that four-fifths of the midges had been destroyed by this parasite. Hence by the good offices of this one species of Chalcid the prospective numbers of the next brood were reduced 80 per cent. The funereal Eurytoma, as it may be called, was bred only from the Washington specimens.

THE MISTAKEN PARASITE (*Platygaster error* Fitch).—The second parasite was bred from specimens of the clover-midge, received from Mr. G. C. Snow, of Branchport, Yates County, New York. Instead of undergoing its transformations entirely within the seed, this parasite develops so slowly that the midge larva has time to leave the clover head, go into the ground, and spin its cocoon before its operations are stopped. The full-grown parasite emerges from the cocoon of its host.

This parasite belongs to the family *Proctotrupidae* and seems to be a species described by Fitch as *Platygaster error*. The specimens described by Dr. Fitch were found in wheat-fields; and he concluded, upon what seem to be very insufficient data, that the insect was an egg parasite

of *Nabis fera*, a long narrow ash-gray bug, slightly over a quarter of an inch in length, which is common on wheat and grass.*

The color of this insect is jet black, with the exception that the anterior tarsi and tips of tibiae are light-brown, while the posterior and middle tarsi are darker. The average length seems to be about 1.3^{mm} (.04 inch). In this respect (Fitch gives the length as .05 inch) and in the color of the tarsi alone do the specimens bred from the clover-midge differ from those described by Fitch.

The "mistaken parasite" has not been bred as yet from the Washington specimens.

THE CLOVER-LEAF MIDGE.

(*Cecidomyia Trifolii*, Löw.)

Order DIPTERA, family CECIDOMYIDAE.

Living within the folded leaf of white clover, from one to twenty minute white to orange colored, footless grubs; transforming within the leaf.

Mr. Lintner little thought when he changed his name of *trifolii* to *legumenicola*, on account of its preoccupation by Löw's European species that the true *trifolii* would so soon turn up in America. Yet such has been the case. A Cecidomyia has been studied the past summer at this department, which corresponds so exactly with *trifolii* that it would be presumptuous for one not an experienced dipterologist to found a new species for it.

About the middle of June last the leaves of white clover (*Trifolium repens*) were observed in many instances to be infested by the larvae of some Cecidomyia. The invested leaves, or more properly speaking, leaflets, were each folded together upon the midrib, so that the upper side would be inclosed, and so that the two edges of the leaflet would almost exactly coincide. The underside of such leaves had a sickly appearance, having turned yellowish or brownish. The fold each side of the midrib was bulged out and gave the leaf a blistered look.

Such leaves, upon being opened, were found each to contain from one to twenty whitish or pale orange maggots, resembling much the larvae of the clover-seed midge, but being somewhat smaller. The younger maggots were nearly white, while the older ones were of a decided orange hue. The average length of the full-grown larvae in 1.5^{mm} (.059 inch). The head is very retractile, and 13 segments of the body are plainly observable. The spiracles are each at the summit of a small tubercle, and are placed as in *C. legumenicola*. The whole surface of the body is very coarsely granulated.

Some of the folds were, at the time of their discovery (June 18), already empty, others contained larvae and others pupae, the latter inclosed in delicate white oval cocoons, fastened to the sides of the leaf.

The cocoons of this species have an important bearing upon the vexed question of the formation of the cecidomyious cocoon. What it may be with others we are not prepared to say, but with *C. trifolii* it is evidently composed of delicate silk.† Another season it is hoped will enable us to watch its formation.

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* Trans. N. Y. State Ag. Soc., 1860, pp. 818–821.

† Winnertz, as quoted by Osten Sacken (Diptera of N. A., vol. I, p. 184), "positively denies that the larvae spin this cocoon; according to his observation, the latter is, so to say, *exuded* by the larva. He found that larvae which had fastened themselves to a leaf, were encircled within twenty-four hours by a white halo, consisting of tiny

The pupa is pale orange in color, with a median ventral stripe of a darker shade. Eyes blackish; upper part of legs and wing cases brownish. The front border of the prothorax projects beyond the head and is quite deeply notched. Two long delicate hairs project anteriorly, and the excurved thoracic horns noted in the pupa of the seed midge are quite prominent.

June 23, the first flies seen made their appearance. They proved to be quite similar to the seed midge. The two most marked differences were that the average size was considerably smaller, and that while the number of antennal joints in *C. leguminicola* was male 15 and female 16, in *C. trifolii* it is male 15 and female 14. There were also many minuter differences, as will be seen upon comparing the technical descriptions.

The leaf midge was quite common upon the department grounds, but was not seen elsewhere. It is to be hoped that this notice of its presence will suffice to put our readers on the lookout for it.

Fig, 5, Pl. I, shows the midge and its work. We give below, in small type, a translation of Dr. Löw's original description of this insect and its habits in the *Verhandlungen der Zoologisch Botanischen Gesellschaft*, Wien, 1874, p. 143.

CECIDOMYIA TRIFOLII, Löw.

Male.—Head small; occiput and clypeus black brown, with black hairs, face brownish, with yellow hairs; eyes black, large, and on the margin bordered with pale hairs; palpi small, yellow, and with yellow hairs; antennae [illegible] long, 14 to 15 jointed, dusky brown, the scape joints globular, pedunculate, the end joint much smaller, peduncles not quite as long as the joints, each joint with two whorls of yellow hair, of which the foremost is long and the hindermost of half the length, each whorl regular and forming a complete circle; thorax reddish brown, scutellum black brown, in some lights shimmering gray, with black hairs and with two small, black, longitudinal furrows, diverging forward, in which the hair is quite thick; metasternum, shoulders, sides of the thorax, and hinder portions with yellow hairs; post-scutellum reddish brown with yellow hairs; legs somewhat thin, brown, lighter on the inner side, ends of joints and tarsi dusky, slightly shimmering from yellowish hairs, coxae reddish brown; balancers pale yellow red; wings [illegible] long, [illegible] wide, scarcely clouded, strongly prismatic, somewhat thickly beset with brown hairs and with brown cilia, root of the wing yellowish brown, costal vein, first and second longitudinal veins strong, black brown, the third longitudinal vein delicate, grayish, first longitudinal vein very near the costal, merging with it a short distance before the middle of the wing; second longitudinal vein almost straight without any upward bend, toward its end it makes a scarcely perceptible inclination forwards and ends in the border before the end of the wing; the third longitudinal vein divides at half the length of the wing, the inner fork being short, much bent, and forming, with the hind border of the wing, almost a right angle, the outer fork almost right angled at the division, shortly carried forward; wing-fold indistinct; cross vein short, almost straight, beyond the middle of the first long vein; abdomen reddish brown, ringed with black, beneath somewhat lighter; first segment beneath reddish brown, all segments on their hinder border with an edge of yellowish hairs, which are a little thicker on the under side; claspers quite large, only a little lighter than the abdomen. Length of the males, 1.3^{mm}.

Female.—A little darker colored than the males; antennae shorter, only 0.7^{mm} long; 14 to 15 jointed, joints not pedicelled; ovipositor long, telescopic, yellowish brown, lighter towards the end; in other respects like the male. Length of the females, 1.6^{mm}.

Larva.—The larva is 1.5–2^{mm} long, light reddish yellow; lives 2 to 4 together in the pod-like folded leaflets of red clover (*Trifolium pratense* L.), and there undergoes its transformations.

Pupa.—The pupa is 1.2 to 1.5^{mm} long, reddish brown; the fore part and wing-covers dusky brown. It rests in a white silken cocoon, which it breaks through and leaves

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thread-like particles, which seemed to grow somewhat like crystal-needles: the larva during this time remained perfectly motionless. The cocoon is perfected within a few days, and even then, under a strong magnifying power, no thread is observable.

Walsh (Proc. Ent. Soc. Phila., 1864, p. [illegible]), referring to these views of Winnertz, says: "I believe that it is in this manner that the pupal cocoon of ALL *Cecidomyia* is formed." Osten Sacken himself seems to have attempted no generalization upon this point.

at the time of transformation. The pupal rest lasts at the most 14 days. The empty pupa skin is entirely white.

Gall.—On the undermost root leaves of *Trifolium pratense*, the leaflets become fastened together by the work of the just described larvae, so that their bent edges fit upon one another so that they resemble little pods. The leaf substance is thereby a little thickened, yellowish or yellow, with brownish specks. On the above-named leaves usually only one leaflet is in this way deformed, seldom all three. Before the midge emerges, the pupa works its way through between the closed edges of the leaf until half its body protrudes.

Occurrence.—This species comes from the meadows of the Sattel Mountain, in the district of Wienerwaldes, is not rare, and one finds their galls in spring. The midge appears at the end of June. From the galls which I had collected on the 20th of June, and in which most of the larvae were already pupating, I reared, on June 28, the first imagines.

THE CLOVER-STEM BORER.

(*Languria mozardi*, Fabr.)

Order COLEOPTERA; family EROTYLIDAE.

Eating out the center of clover stalks for a greater or less distance; rather long, slender, yellowish larvae, transforming within their burrows and eventually becoming slender reddish beetles, with dark blue wing covers.

A new clover pest has been discovered the past summer, in the shape of this well-known insect; for, although the beetle is ranked as common by collectors, its larval habits have not, I think, been heretofore described. (Pl. I, fig. 6.)

In localities where this beetle is abundant, if the stems of red clover be carefully examined some time in June, on many of them will be seen one or more small discolored spots, which seem to have been made by the gnawing of some insect. If one cuts into the stem at one of these spots, a slender yellowish egg, 1.7^{mm} (about $\frac{1}{15}$ inch) long, rounded at both ends and somewhat curved, will be found imbedded in the pith; the gnawing having evidently been done for the purpose of penetrating the comparatively hard exterior and allowing the egg to be easily pushed in. Often the egg is found as far as 6^{mm} (nearly $\frac{1}{4}$ inch) from the opening, which shows that the mother insect must have forced her whole body into it.

The larvae hatching from these eggs are slender, almost worm-like in form, and feed exclusively upon the pith of the stalk. While they do not kill the stem outright, they gradually weaken it and eventually cause its destruction, having also, of course, a very injurious effect upon the maturing of the seed. The egg is usually laid high up in the stem and the larva usually burrows downwards, often extending its work for a distance of from six to eight inches below the point of entrance. The full-grown larva is about 8^{mm} (.315 inch) in length, yellow in color, with six prominent thoracic legs and a prop leg at the posterior end of the body. The last segment of the body has two stiff, slightly upward-curved spines above.

Upon attaining full growth the larva transforms to a pupa in the lower part of its burrow. The pupa is about 6^{mm} long, slender, with a large head, and is yellow in color. The adult beetles begin to issue in August and are continually making their exits until late in October.

There is probably but one brood in a season, and the insect hibernates in the beetle state. An examination of many stalks during the winter failed to show the insect in any stage of growth.

Two parasites were found within the burrows of the stalk borers, the one a small black chalcid, the dark, naked pupa of which was often met

with, and the other a yellowish ichneumonid, the pupa of which was inclosed in a delicate white silken cocoon.

It seems probable that where clover is regularly cut in early summer and again in fall this insect will not increase to any alarming extent; but where this is neglected, or where there is much waste clover, it may do considerable damage.

We append a more extended description of the larva.

LANGURIA MOZARDI.

Larva.—Length 8^{mm}; color light yellow; tips of mandibles and anal horns brown. Subcylindrical in shape, the anal segment only being narrower than the preceding joint. Average width, $.9^{mm}$. Thoracic legs long and stout; only one prop leg, which is under the anal segment. The anal segment is armed upon its dorso-posterior border with two upward-curved acute hooks placed close together. The head is broad, somewhat flattened dorso-ventrally. Antennae prominent, 4-jointed, 3d joint longest, 4th joint slender. Labrum broad, rounded, with a row of small piliferous tubercles at its anterior border. Mandibles, 3 toothed. Maxillary palpi, 3 jointed. Labrum rounded anteriorly; labial palpi 2-jointed, stout.

THE CLOVER OSCINIS.

(*Oscinis trifolii*, Burgess [n. sp.].)

Order DIPTERA; family OSCINIDAE.

Mining the upper surface of the leaves of *Trifolium repens* (white clover); small, greenish-white maggots, transforming under ground, and ultimately becoming active, minute, two-winged flies, yellow and black in color.

If the leaves of white clover (*Trifolium repens*) in the District of Columbia and vicinity (we are not aware that it will be the case elsewhere) be examined some time during the month of June, many of them will be found to be mined under the upper membrane in a curious and irregular manner. With some leaves the whole upper surface will seem to have been separated and the parenchyma eaten out; with others the mine will not occupy more than a third of the surface. The mined portion of the leaf has a greenish-white color, while the lines of black excrement plainly marking the course of the inhabitant of the mine can be easily seen, and add very much to the peculiar appearance of the leaf. Removing the upper cuticle, the miner is found to be a very small, rather slender, greenish-white maggot, 1.7^{mm} (.068 inch) in length, tapering toward the head. The head and first segment taken together resemble much, when highly magnified and viewed from the side, the head of a fat pig, the prothoracic spiracular tubercles appearing like ears. The last joint of the body is prolonged above into two rather large conical tubercles, each of which is at its extremity divided into three quite prominent downward-curved lobes. Besides these dorsal tubercles the anal segment has also a pair of postero-lateral tubercles and a pair of ventral ones. The three thoracic segments also have each a pair of small ventral tubercles which assist in locomotion, and may be rudimentary legs.

Toward the latter part of June these larvae break through the upper leaf skin and fall to the ground, where they work their way for a short distance beneath the surface and transform in an hour within oval, yellowish-brown puparia, about which there is nothing sufficiently characteristic to merit description.

In somewhat less than two weeks the perfect flies begin to make their appearance. They are very small, about 1.3^{mm} (.05 inch) in length, stout,

rather hairy, yellow in general color, with brownish backs and red-brown eyes. They belong to the family *Oscinidae*, and are quite closely related to the wheat, rye, and barley flies belonging to the genera *Meromyza*, *Chlorops*, and *Oscinis*.

There are certainly two, and probably three, broods of this insect in the course of a year, judging from the rapidity of the development of those studied the past season; and the insect probably winters in the pupa state under ground.

Specimens of the flies were sent to Mr. Edward Burgess, who pronounced them to be a new species of the genus *Oscinis*, for which he proposed the specific name of *trifolii*, and submits the following characterization:

OSCINIS TRIFOLII, Burgess, sp. nov.

Yellow: Occiput, ocellar triangle, dorsum of the thorax and abdomen, spot on coxae and on each side of scutellum, black. Scutellum with four black bristles. Front face, cheeks, and orbits of the eyes yellow; occiput and ocellar triangle black. Antennae yellow; bristle black, pubescent. Dorsum of thorax black, rest yellow. Scutellum yellow with a narrow blackish spot on each side, extending to the base. Bristles four, black. Dorsum of the abdomen black, margin and venter yellow. Tip brownish. Wings transparent, veins brownish, at base yellow, 3d and 4th longitudinals slightly divergent at tip. Halteres golden yellow. Legs pale yellow, tarsi infuscated at tip; hind tarsi more so. Hind tibiae with a darker streak above. Coxae with a dark spot on outside.

Length of body, $1\frac{1}{3}^{mm}$; of wing, $1\frac{1}{2}^{mm}$. Habitat, District of Columbia. Larva mines white clover leaves.—[Professor COMSTOCK.

THE MALLOW OSCINIS.

(*Oscinis malvae*, Burgess [n. sp.].)

Order DIPTERA; family OSCINIDAE.

Making an irregular linear mine, first above the under, afterwards beneath the upper surface of the leaves of *Malva rotundifolia;* a minute, greenish white larva, which leaves the mine to transform, and eventually becomes a small, bristly, black fly.

Quite closely allied to the clover Oscinis is another species of the same genus, which has been studied the past season for the first time. The eggs of the adult fly are laid singly upon the under surface of the leaves of common mallow (*Malva rotundifolia*) which the larva mine. The mine is at first visible only from the under side of the leaf, as the larva keeps close to the under skin. It is then so delicate as hardly to be perceptible to the naked eye. In form it is linear and waving, increasing in diameter as it progresses. When the larva is somewhat less than half-grown it changes suddenly from the under to the upper side of the leaf, or from just above the under skin to just beneath the upper, so that the mine is no longer visible from the under surface. From the upper surface, however, it soon presents a most fantastical appearance, especially upon the smaller leaves, where it is looped and knotted and twisted until it is hard to distinguish beginning from end. The color of the mine upon the upper surface is nearly white, while upon the lower surface it is bluish green. A close examination shows an almost continuous string of black excrement through the center of the mine.

When full grown the larva is found in an enlargement of the mine beneath the upper surface. When ready to transform, it cuts a slit through the bottom of the mine and drops to the ground from the *under* side of the leaf. The full-grown larva is 2.5^{mm} (.097 inch) in length, and resembles much in form that of the clover Oscinis. It is greenish-yellow in

color. The anterior end of the body is nearly pointed and the posterior end is truncate. At the juncture of the segments is a somewhat elevated, broad ridge, which carries several rows of minute, backward-directed teeth. The last segment has its spiracles mounted upon a pair of quite long, slender tubercles, directed backward and curved inward, and the prothoracic spiracles are also mounted on similar, though smaller, projections.

The puparia are 1.8mm (.07 inch) in length, dark-brown in color, and oval in shape. From each end of the body projects a pair of slender, diverging, conical tubercles, which are the prothoracic and anal spiracular tubercles mentioned in the description of the larva. There are only ten segments of the body distinguishable, each well marked and rounded.

The mines of this insect were not noticed until October 23, although there probably was one if not more earlier broods. The flies from the mines, collected on the date mentioned, began to issue November 14. They were stout, active, hairy, little black flies, resembling the clover Oscinis in general form, differing, however, in color and in being somewhat larger. Specimens were forwarded to Mr. Burgess, who deemed it necessary to found a new species for them, and sent the following description for publication:

OSCINIS MALVAE, Burg., sp. nov.

Black; face, lateral stripes on thorax, and halteres bright yellow. Scutellum with six bristles. Front yellow, borders on each side, above, dusky; ocellar triangle and antennae black; bristle with fine pubescence; face and cheeks yellow. Thorax black, a broad, bright-yellow, longitudinal stripe on either side, which includes the base of the wings. Scutellum black, with six long bristles. Abdomen bristly, black. Wings slightly clouded, roots yellow, veins, except the costal, pale, darker towards the tips. Third and fourth longitudinals nearly parallel. Halteres bright yellow. Legs brownish-black, knees of the first pair paler. Length of body, 1.5mm; of wing, less than 2mm.

Habitat, District of Columbia; larva mines leaves of *Malva rotundifolia*.—[Prof. J. H. COMSTOCK.

INSECTS INJURIOUS TO ORANGE TREES.

The production of oranges has become a very important industry in the more southern parts of the United States, especially in Florida, Louisiana, and California, and the number of orange groves under cultivation is increasing with marvelous rapidity. It seems probable that in the near future a very large proportion of the oranges consumed in this country will be produced from our own soil. The fact that imported oranges cannot compete in delicacy of flavor with those grown in some parts of the United States renders this more certain, provided the trees can be kept free from the various diseases to which they are subject.

The importance of guarding against the ravages of insects seems to be appreciated by many orange-growers. Excepting cotton, there is no crop respecting the insect enemies of which we have received more inquiries during the past year than that of oranges. And so little has the subject been studied by entomologists that in many cases we have been obliged to answer the inquiries by a confession of ignorance. Finally, it was concluded to undertake a thorough investigation of the insect enemies of the citrus fruits grown in the United States. To this end a trip was made through the State of Florida during the months of January and February, 1880. The object of this journey was simply to make a reconnoissance, so that the investigation could be conducted intelligently and economically. During the trip, however, we carefully collected specimens of all the insects found infesting trees of the genus *Citrus*, and as full notes made upon their habits as was possible in the limited time at our disposal. Living specimens were forwarded to Wash-

ington and colonized on orange trees in the breeding-room. In this way we have been able to watch the development of all of the more important species from the egg to the adult state. Especial attention has been given to the "scale insects," and the life histories of the more important Florida species have been worked up. We give in this report only a few of the facts thus learned, as we have been unable, through lack of time, to prepare for the press the greater part of the material at hand. We hope during the coming year to visit other parts of our orange-growing sections, and to conduct a series of experiments with remedies. A full report on this subject will be prepared as soon as practicable.

THE COTTON STAINER ON ORANGE.

(*Dysdercus suturellus*, H. Schf.)

Order HEMIPTERA; family CECIGENAE.

Puncturing the rinds of oranges and sucking their juice, causing them to decay and fall to the ground; red-bugs, 17mm. (.67 inch) in length, with the segments of the body margined with white, and with dark wing-covers.

From time immemorial the so-called "cotton stainer" or "red-bug" has been one of the worst pests with which the cotton planters of Florida and the West Indies have had to contend, and it would be difficult to estimate the immense loss it has occasioned. It does much damage by piercing the stems and bolls with its beak and sucking the sap, but the principal injury to the crop is from the staining of the cotton in the opening bolls by its excrement.

Quite recently, however, it has developed a habit which bids fair to place it much nearer the front in the ranks of our injurious insects even than it has been before. My attention was first called to it by a letter from Mr. S. W. Carson, of Fort Meade, Fla., dated December 18, 1879, from which the following is an extract:

I send you to-day some bugs which are excessively injurious to sweet oranges after they ripen. The tree from which these were taken had thousands on it. They set to sucking, and never cease until the rind is punctured to the pulp; and soon decay sets in, and the fruit drops. Scores will fall off in twenty-four hours. We are ruined in the orange culture if they continue.

In consequence of this letter from Mr. Carson, we endeavored to find, during a subsequent trip to Florida, instances of similar injuries; but are unable to report any from personal observations. However, the red-bug was repeatedly pointed out to us by men of intelligence and accurate observation as being an insect which infests oranges in the manner described. The principal injury seems to have been done where cotton was planted in close proximity to the orange groves. Mr. Samson, of Micanopy, informed us that one season he planted cotton between the rows of his grove, and lost nine-tenths of his crop of oranges in consequence. Some trees shed every orange. He stated that the puncture of the bug looked like a mosquito bite, a minute sting, about which the orange changed color, becoming yellow (the orange being green). Later the orange would drop, and upon examination the pulp would be found to be rotten.

I first met with the cotton-stainer at Rock Ledge. It was then quite common on the leaves of guava, which were infested by a mealy bug (*Dactylopius*, sp.). The cotton-stainers were feeding busily, but whether it was upon the sweet excretion of the mealy bug or upon the leaves of the plant, I was unable to judge. At Maitland, Orange County, I found

it quite abundantly upon a native species of rose mallow (*Hibiscus*, sp.) and also upon a foreign introduced species (*H. fulgidius*). I was informed that it was very abundant upon plants of this genus along the Saint John's River.

The eggs of the cotton-stainer were sent to the department in April, by Mr. H. S. Williams, of Rock Ledge, Fla. They were laid in a group of twenty-one upon the under side of an orange leaf. They were amber colored and oval in shape. The young bugs made their exit through nearly circular holes on the upper side, near one end. The eggs appear smooth and glistening to the naked eye, but an examination with a lens shows them to be densely covered with hexagonal impressions. The young bugs are bright red, with black legs and antennae. In form they resemble the adults, but are wingless.

As to remedies, the only ones which have been suggested were given by Mr. Glover in the annual report of this department for 1875. Mr. Glover says:

> These insects being in the habit of collecting together where there were splinters or fragments of sugar-cane on the ground, advantage was taken of this fact to draw them together by means of small chips of sugar-cane laid upon the earth near the plants, where they were at once destroyed by means of boiling water. They also collect around heaps of cotton-seed, where they may be readily destroyed at the commencement of cold weather. Small heaps of refuse trash, dried cornstalks, or especially of crushed sugar-cane may be made in various parts of the plantation in the vicinity of the plants; under these the insects take shelter from the cold, and when a sufficient quantity of the bugs is thus drawn together, the various heaps may be fired and the insects destroyed with the trash. A very cold morning, however, should be selected, and the fire made before the insects have been thawed into life and vigor by the heat of the sun; and especially all dead trees, rotten stumps, and weeds in the vicinity of the field should be burned or otherwise destroyed, as they afford a comfortable shelter for all sorts of noxious insects. Crushed sugar-cane (bagasse) mixed with some poison (say Paris green), if imbibed by these insects, would no doubt destroy many of them, but might also be taken by domestic poultry or hogs.

The ill-advisability of planting cotton in close proximity to orange groves will be readily seen, while the necessity of destroying the rose mallows in the vicinity is just as perceptible. I was forcibly struck with the attraction which piles of cotton-seed possess for the bugs, and think it probable that small heaps of this seed in different parts of the grove will prove a most efficient trap for them. I saw this insect gathered in almost incalculable numbers upon such a heap at Maitland, Fla.; when so gathered they could easily be destroyed by pouring hot water upon them.

From the color of these insects it was thought many years ago that a serviceable red dye might be made from their expressed juices. Experiments were made by Dr. Charles T. Jackson, of Boston, who discovered that while no *red* dye could be obtained, the whole substance of the insect could be converted into a rich orange-yellow dye, which was readily fixed on woolen or silken fabrics by the alum mordant liquor. The cloth, previously boiled in a solution made by adding two ounces of alum to a gallon of water, was dipped into solution of the insects made by dissolving them in boiling nitric acid. After this the cloth was soaked in a solution of half a pint of ammonia added to a gallon of water. The yellow color produced also answered excellently as a basis for green and brown dyes.*

A predacious bug, known as *Leptocoriza tipuloides* Latr., was also frequently found upon the orange tree, and bears more or less of a resemblance to the red-bug in size and coloration. It is slenderer than the red-bug and has longer limbs, its name, *tipuloides*, being doubtless given to it from

* See Dept. of Agr. Ann. Rept., 1858, p. 272.

this fact. The red color is lighter than on the red-bug, and the back lacks the Saint Andrews cross which characterizes the other. The *Leptocoriza* does no harm to the crop whatsoever, but preys upon the different insects to be found upon the trees. True, it is not as discriminating as it might be, and frequently devours the beneficial *Chrysopa* larvae, but its good qualities undoubtedly outweigh its bad, and it should not be destroyed with its injurious relative.

THE ORANGE-LEAF NOTHRIS.

(*Nothris citrifoliella*, Chambers [n. sp.].)

Order LEPIDOPTERA; family TINEIDAE.

Webbing together the half-grown leaves of new shoots of the orange, eating the leaves and destroying the bud; a cylindrical yellow worm, with black head and first segment, dropping by a thread when disturbed.

Specimens of this insect were last summer received from Brevard County, Florida. We do not know enough of its habits at present to do more than describe it and its method of work.

According to Mr. H. S. Williams, of Rock Ledge, the larvae have been very injurious to the orange trees in his vicinity. They infest the young leaves of the new growth. These they web together by a delicate white silken web, and feed upon the bud, entirely stopping the growth of the shoot. If disturbed, the worm drops by a thread. It is very active, and when removed from its web runs quite quickly.

The full-grown larva measures about 12^{mm} ($\frac{1}{2}$ inch) in length. It is yellowish in color, with the head and first thoracic segment black and somewhat polished. The posterior margin of the black thorax is pale-yellow. The anal plate and legs are polished yellow, with the scattered hairs upon the former blackish; all other hairs are yellow. The first pair of legs is black and the rest yellow.

When ready to pupate, the larva rolls a leaf around itself and spins a delicate silken cocoon, in which it transforms to a rather stout, dark-brown chrysalis. There is nothing so characteristic about the chrysalis as to merit description. The moths emerged from August 25 to September 5. The following is Mr. Chambers's characterization of the species:

NOTHRIS CITRIFOLIELLA, n. sp.

It is possible that this species may already be known in Southern Europe, or in other orange-growing countries; but I have met with no account of it in any work to which I have access. If known, it ought to be found in Mr. Stainton's "Tineina of Southern Europe," but I have been unable to find any copy of this work in this country. A note addressed some months ago to Mr. Stainton remains unanswered. As the species is certainly new in this country, and I have not been able to hear of it elsewhere, I describe it as new. Yet, if the orange is its only food-plant (and none other is known as yet), and the orange is not indigenous here, it is probable that the insect has been imported with its food-plant, and, even if it is as yet undescribed, will be found in other orange-growing countries.

The moth is ochreous-gray, or more properly, perhaps, grayish-ochreous (under a lens it is ochreous dusted with fuscous). Outer surface of the second joint of the palpi brown, except the anterior margin of the tuft, which is pale-ochreous, from the middle of which springs the acicular third joint, which is pale-ochreous tinged with fuscous, and is longer than the second joint. On the disc of the fore wings, at about the basal fourth of the wing-length, is a short, obscure, oblique, reddish, fuscous streak, behind which is a small brown discal spot, with another like it placed opposite to it and touching the fold; further back on the disc are two similar brown spots, and a little further back, on the dorsal margin at the end of the fold, is a much larger spot or patch of the same color; behind the discal nervure the wing is paler and shows indistinctly a wavy, transverse, fuscous streak, and there are five circular black spots around the apical margin; the cilia are pale fuscous. Hind wings pale-grayish fuscous,

scarcely excised beneath the tip. The antennae are minutely pectinated and microscopically pubescent, ochreous, dotted with fuscous on the upper surface, and with the upper surface of the basal joint fuscous. Abdomen ochreous dotted with fuscous. Legs stained with fuscous on their anterior surfaces. Al. exp. $\frac{11}{16}$ inch (17 to 20mm., J. H. C.).

NOTE.—Since the above description of *N. citrifoliella* was prepared, I have received a note from Mr. Stainton, in which he states that "The Nothris from leaf buds of orange trees is something quite unknown to me. Your sketch of the fore wing is quite in the style of *N. Durdhamella*."

THE ORANGE CASE-BEARING TINEID.

(*Coleotechnites citriella*, Chambers [new species].)

Order LEPIDOPTERA; family TINEIDAE.

At Manatee, Fla., in the latter part of April, I found upon the trunk of an orange tree the case of a Tineid larva. This case was rather slender, 11mm (.43 inch) long, and rather pointed at the hinder extremity. It was dark gray in color, resembling the bark upon which it was found, and was apparently composed of small bits of lichens and excremental pellets, with much gray silk. The moth issued March 6, and upon being referred to Mr. Chambers proved to be a new species representing a new genus. The following are Mr. Chambers' descriptions:

COLEOTECHNITES Chambers (new genus).

Fore wings lanceolate; the cell closed; the subcostal gives off a branch about its middle and then others near to its tip; the last one giving off a branch behind which it becomes furcate with one branch to each margin; median two branched, and the discal sends a branch to the dorsal margin. Submedian furcate at the base. Hind wings about as wide as fore wings; cell indistinctly closed; subcostal with a branch to each margin before the tip; median then branches, a single discal branch; submedian and internal veins indistinct; two folds through the discal cell; hind margin somewhat excavated beneath the tip.

Head depressed; forehead obtuse; tongue moderately long; no maxillary palpi; labial palpi porrected, the second joint with a tuft which spreads both above and below the apex; third joint deflexed, shorter than the second; antennae simple, more than half as long as the fore wings.

C. CITRIELLA Chambers (n. sp.).

Pale sordid ochreous; there is a fuscous spot near the top of the third palpal joint; antennae pale sordid ochreous annulate with fuscous; fore wings pale sordid ochreous irrorate with fuscous (especially so along the disc) but paler on the dorsal margin. There are three dark-brown or blackish oblique costal streaks reaching the middle and then produced backwards, the last one produced back to the apex. The first of these streaks is near the base of the wing, and extends along the costa to the base, the second before the middle, and the third at about the apical third of the wing length. The apical part of the wing is darker than the remainder. Abdomen and legs pale sordid ochreous, the latter annulate with fuscous and the first and second pairs dark fuscous on their anterior surfaces. Al. ex. not quite half an inch.—From Florida.

Professor Comstock informs me that the larva lives in a case, of which he sent me an example, and that it feeds upon the orange. The case is an oblong cone of silk lined externally with fragments of frass and other *débris*.

BLASTOBASIS CITRICOLELLA Chambers (new species.)

Order LEPIDOPTERA; family TINEIDAE.

From a dry orange which was found at Jacksonville, Fla., in the latter part of January, and preserved on account of its being infested by a small beetle (*Araeocerus fasciculatus*), there issued rather unexpectedly on March 17 a small gray Tineid moth, which was referred to Mr. Cham-

bers for determination. He pronounces it a new species of Blastobasis, and characterizes it as follows:

BLASTOBASIS CITRICOLELLA Chambers (n. sp.).

The elongate, rather narrow face, and the fact that the submedian vein of the fore wings gives off a branch to the dorsal margin from about its middle (which I have not observed in any other Tineid), at first inclined me to separate this species from *Blastobasis*. Like *B. coccivorella*, it has a large tuft projecting from the base of the basal joint of the antenna, and forming a sort of eye cap. Head, thorax, and fore wings sordid, white, dusted with fuscous on the wings; the fuscous scales are arranged in longitudinal streaks along the disc, and the fold is fuscous; antennae sordid white, annulate with fuscous; hind wings and abdomen stramineous.

Al. ex. not quite $\frac{3}{8}$ inch. A single female, said by Professor Comstock to have been bred from "a dry orange."

THE ORANGE-LEAF NOTCHER.

(*Artipus floridanus* Horn.)

Order COLEOPTERA; family CURCULIONIDAE.

Eating jagged notches in the edges of orange leaves; a small whitish snout-beetle, $\frac{1}{4}$ inch in length.

In July, 1879, specimens of this beetle were received from Mr. H. S. Williams, of Rock Ledge, Fla. He stated that they only appeared in a limited portion of his grove, but that in this one locality they were very abundant. He said that he had killed hundreds, and yet every morning about so many were at work.

I visited Mr. Williams's place in the spring of 1880, and at that time the beetles were still at work, and had spread but little from the original spot. Experiments showed that they drop readily whenever the tree upon which they are at work is jarred, and hence they may be easily caught upon sheets and destroyed, as is done with the common plum curculio. (See Plate III, fig. 3.)

WHITE ANTS, OR "WOOD LICE."

(*Termes flavipes* Kohlar.)

Order NEUROPTERA; family TERMITIDAE.

Girdling the bark of orange trees and guava bushes near the surface of the ground, or eating out the interior of sugar-cane and other plants: numerous small white insects, resembling ants in form and size.

These insects, which are common throughout our territory from Massachusetts to Florida, are usually found living in communities in logs, sticks, and stumps. Decaying pine wood is especially liable to be attacked by them. Sometimes they are very destructive to wooden structures, as houses, bridges, and fences, and especially to such parts as are near the ground.

This season we have learned that they do not confine their attacks to dead vegetable matter, but that they frequently infest and destroy living plants. We received specimens from Mr. B. F. Weems, of Houston, Tex., that were infesting pampas grass and orange trees; and I found them common throughout Florida, infesting orange trees, guava bushes, and sugar-cane. In the last-named State these insects are generally recognized as important pests. They are there known as "wood lice," a name whose use is to be deprecated, as it tends to create confusion.

When white ants infest living plants, they attack that part which is at or just below the surface of the ground. In the case of pampas grass, the base of the stalk is hollowed; with woody plants, as orange trees and guava bushes, the bark of the base of the trunk is eaten, and frequently the tree is completely girdled; with sugar-cane, the most serious injury is the destruction of the seed cane.

The white ants may be destroyed by water heated sufficiently to kill the insects without injury to the infested plants. In the case of orange trees, much can be done to prevent the attacks of these insects. My experience convinces me that it is those trees about the crown of whose roots the soil has been heaped that are most liable to become infested. It follows that care should be taken to remove such soil immediately after each cultivation of the grove, leaving the crown of the roots exposed. It is also important to remove all old wood, especially pine, from near the trees, as such wood is liable to become infested and the white ants to spread from it to the orange trees.

TWO NEW PARASITES ON ORANGE INSECTS.

The leaves of the terminal twigs of orange trees are frequently infested, especially in the spring, by numerous dark-green plant-lice, which do considerable injury by checking the growth of the young shoots. At Rock Ledge, Fla., I found that these plant-lice were destroyed in great numbers by a small black Ichneumon fly, a description of which has not heretofore been published. I bred the same species from plant-lice infesting the cotton plant, and from the common grain plant-louse (*Aphis avenae*). The specimens were referred to Mr. E. T. Cresson, who prepared the following characterization of the species:

TRIOXYS TESTACEIPES Cresson (n. sp.).

Female.—Piceous or shining black, smooth and polished, impunctured: mandibles and palpi pale; antennae brownish-black, sometimes more or less pale beneath, 13-jointed, the joints faintly fluted or grooved, the last one longest and thickest; wings hyaline, iridescent, stigma pale; legs, including coxae, yellowish-testaceous, the posterior pair generally more or less fuscous or blackish; abdomen often brown or pale piceous, with the first, and sometimes part of the second, segment more or less testaceous. Length, .07 inch.

Hab.—Rock Ledge, Fla., Selma, Ala., and Pocomoke City, Md. Parasitic upon an aphid infesting twigs of orange, an aphid on the cotton plant, and *Aphis avenae* Fabr.

Another undescribed species of Ichneumon fly was bred from cocoons which I found upon an orange leaf at Rock Ledge, Fla. This species is probably parasitic on some larvae infesting the orange tree. It was also referred to Mr. Cresson, who characterizes it as follows:

POLYSPHINCTA ALBIPES Cresson (n. sp.).

Male.—Sanguineous, smooth and polished; head black; clypeus, mandibles and palpi, white: antennae long, slender, black; tegulae and dot before, white; wings hyaline, subiridescent, nervures and stigma fuscous; legs, including coxae, white, tips of tarsi blackish; second and following segments of abdomen with a transverse black spot on each side at tip, and a transverse deeply impressed line near base and apex, the lateral middle being therefore more or less swollen; basal segment with a median shallow groove above, and a short, stout tubercle on each side; venter yellowish-white. Length, .28 inch.

Hab.—Rock Ledge, Florida. Found on an orange leaf.

THE PALMETTO-LEAF MINER.

(*Laverna sabalella* Chambers [new species].)

Order LEPIDOPTERA; family TINEIDAE.

Feeding in small companies upon the upper surface of the leaf of the saw-palmetto, under a silken covering, cylindrical white larvae with longitudinal brown stripes, yellow heads, and yellow first segments. (Pl. II, fig. 1.)

In the spring of 1879 specimens of a leaf miner on the leaves of the saw-palmetto (*Sabal serrulata*) were sent to the department by Mr. Schwarz, from Florida. During the summer the moth was sent to Mr. Chambers for identification, but it proved to be a new species. He accordingly named it, and his characterization of the species is appended.

During my entomological excursion to Florida in January and February, 1880, I again met with the species, and collected many specimens in all stages. Along the Transit Railroad, between Fernandina and Baldwin, it was very common, and in other parts of the State it was occasionally seen. In a few instances I found this species feeding upon the leaves of the young cabbage palmetto (*Sabal palmetto*).

The larva feeds upon the upper surface of the leaf, destroying the upper skin and the fleshy part of the leaf, leaving the lower skin untouched. I have never found it feeding upon the under surface. The larvae are social in their nature, working together in small companies, several making a common nest. This nest consists simply of a delicate sheet of silk, covering that part of the leaf upon which the larvae are working. This silken sheet is covered externally with a layer of what appears to the unaided eye like sawdust, but which is in reality a mass of the excrementitious pellets of the larvae. The true nature of the work is thus concealed, both the silken covering and the larvae themselves being hidden from view. The nest is always kept extended beyond the eaten portion, so that the larvae are under cover while eating. Both the disk and the terminal portions of the leaf are infested. In many cases the latter were fastened together lengthwise, as if they had never been unfolded, or had been drawn together. From the line of union the excrement always projects.

The average length of the full-grown larvae is about 14^{mm}. (.55 inch). They are comparatively slender and subcylindrical in form. The ground color is white tinged with yellow, the head and prothoracic shield being a darker yellow and the mandibles brown. Extending longitudinally from prothorax to anus are eight somewhat irregular, reddish-brown stripes, at equal distances apart around the whole body. These stripes grow more pronounced as the larva increases in age. The larvae are active in their movements, and when removed from their mines drop readily by a thread. A strange peculiarity of the color of the brown stripes is that upon the larva being placed in alcohol they change to a brilliant pink or rose color. The same effect is also produced when they are mounted in Canada balsam.

The chrysalis is formed under the silken covering. It is about 8^{mm} ($\frac{3}{15}$ inch) in length and is rather slender. The abdomen is reddish and the wing-covers yellowish brown. It is smooth and shining. The wing sheaths extend to the eighth abdominal segment.

The moth is quite large for a Tineid, the expanse of the wings being 15.5^{mm} ($\frac{5}{8}$ inch.) Its general color is a delicate silvery gray, with a tinge

of lavender in some individuals. There are two minute black spots towards the hind margin of each front wing.

Although the saw-palmetto is not of much service in the arts at present, still it is used to a certain extent in the manufacture of paper, and this utilization bids fair to increase. Hence our leaf miner, although hardly to be ranked as injurious at present, may become so at some not far distant day.

A Chalcid parasite has been bred from this insect, which will be described in a future report.

The following is Mr. Chambers's characterization of the species:

LAVERNA SABALELLA, n. sp.

Very pale ochreous yellow, or perhaps rather stramineous. Outer surface of the second joint of the palpi brown. There is a small brown spot on the fold near the hind margin of the fore wings, and a larger one at the end of the disk nearer to the costal than to the dorsal margin. *Al. exp.* $\frac{3}{8}$ inch.

The wings are more elongate and narrow than in *L. gleditschiaella*, but the palpi are slender and acuminate as in that species. The larva feeds on the upper side of the palmetto (*Sabal*) in Florida. It forms of its frass or excrement large tubes or galleries under which it lives.

THE RESPLENDENT SHIELD BEARER.

(*Aspidisca splendoriferella*, Clem.)

Order LEPIDOPTERA; family TINEIDAE.

Mining the leaves of apple twice a year and cutting out an oval case, which it carries to the trunk or limbs and attaches, a minute whitish footless larva, with a brownish head and a yellow-brown spot on each segment.

It is not an uncommon sight in this latitude* to see during the winter numbers of little oval disk-shaped yellowish bodies, 3mm (.1 inch) long, and bearing a resemblance to some kind of seed attached to the trunks and branches of apple trees. (The general appearance of these disks is shown in Pl. II fig., 2.) If one of these is examined closely it will be seen to consist of nothing more than a section of apple leaf, looking as though it might have been clipped from the leaf by a punch. If sufficient curiosity is aroused to impel one to a further examination, and if the disk be pulled apart, it will in all probability be found to contain a small yellowish contracted larva, which, had it been left undisturbed, would have changed to a chrysalis early the ensuing spring and later to a moth.

During the month of May, after the apple leaves have attained a sufficient size, I have often watched the brilliant little adult of this insect running about upon the upper surface of the leaves in the bright sunlight with their wings folded close along their sides. I have never seen them deposit their eggs, and this is probably done at night. Neither have I ever been able to find their unhatched eggs, though the shells are plainly observable on the upper side of the leaf after the mine is sufficiently far advanced to show one where to look for them.

The young larva, hatching, penetrates to the interior of the leaf and begins a linear mine, which as it increases in size becomes an irregular blotch obliterating the early linear portion. The nearly completed mine bears a slight resemblance to that of *Tischeria malifoliella*, which is frequently found upon the same leaf, but differs in the fact that

* It is impossible to say what the geographical range of this insect is. Mr. Sanborn bred it in Cambridge, Dr. Clemens presumably in Philadelphia, and Mr. Chambers at Covington, Ky.

the mine of the latter is only observable from the upper side of the leaf, while that of our insect can be seen from both sides and is also of a darker color.

The mine when completed is an irregular, frequently more or less triangular, rather dark colored blotch, averaging 6 or 7mm in its longest diameter and observable from both surfaces of the leaf. Up to the time when the larva has attained full growth the mine is translucent, the only dark spots being the larva itself and the excrement which is collected in an irregular cake of minute pellets in the region where the mine was first begun. Soon, however, the translucency of the broader end of the mine begins to be obscured in an oval spot, and if it could be opened the larva would be found busily engaged in lining both surfaces of the leaf with white silk, mapping out the size and shape of its future case. After this lining has become sufficiently thick, the larva commences to cut through both surfaces of the leaf at the edge of the oval lining, and to draw them together and fasten them with silk as it goes. When the circumference of the oval has been cut and fastened, with the exception of a small portion at one end, the larva at that point cuts through the *upper* surface alone, partly issues from its case, and weaves a strong cord of silk from the surface of the leaf on beyond the mine back to the mouth of the case. Then, everything being securely fastened, it cuts the last band of the lower membrane which still remains intact, and stands upon the upper surface of the leaf with its completed case upon its back. The next step is to cut the supporting cord, and the larva is free to start upon its travels.

In walking, the head and first three thoracic segments alone are protruded from the case, the soft hinder parts being thus protected. The abdomen with the inclosing case is lifted erect in the air, so that it does not drag upon the insect as it walks. After progressing for an inch or so the larva usually drops from the leaf, spinning a long silken thread as it falls. In this way it either reaches the ground, or, what is much more common, falls upon or is blown by the wind to a limb or the trunk. It travels a greater or less distance further until it finds what seems to it to be a proper place, and there, after attaching the case firmly to the bark by a button of silk, it sooner or later transforms to a pupa.

No food is taken after the case is begun. The posterior end of the case is left slightly open, although there is no necessity for an anal opening through which to pass the excrement, as in *Coleophora*; neither is any excrement to be found in the case, all having been left behind in the mine. After fastening its case permanently, but before transforming to the pupa state, the larva reverses its position in the case, so that its head is towards what was formerly the posterior end.

When the time arrives for the moth to make its exit, the pupa works its way out through the posterior slit in the case until it is half emerged, and in that position gives forth the moth.

Dr. Packard* speaks of the forming of the cases in the latter part of August and September. Mr. Chambers† also states this to be the customary time, and August was the month in which Dr. Clemens‡ found them. In Washington, however (and this would probably hold true in the field of Mr. Chambers's observations), there are two broods in the course of the season. During the past summer the first cases were observed on July 16, and July 23 the first moth issued, and from this date till the middle of August they were continually issuing. This first brood

* Guide to the Study of Insects, p. 355.
† Canadian Entomologist, vol. iii, p. 223.
‡ Proc. Acad. Nat. Sci. Phil., 1860, p. 12.

was quite numerous, but when the second brood began to make their cases, about the end of September, the apple trees were a sorry sight to the orchardist. I have frequently counted from twenty five to thirty separate mines in a single leaf, from which one can see what a great drain this insect must have caused upon the vitality of the plant. In early October, when permanent hibernating quarters had been taken up, the tree trunks and larger branches were fairly covered with the clustering cases. I have counted forty-seven on a spot of bark not larger than a dime. In the crotches of the limbs, in the crevices of knots, and in similar places they were particularly abundant. They were also to be found upon the grass and sticks at the base of the tree.

The individuals of the first brood transform to pupae almost immediately upon permanently fastening their cases, but the members of the last brood hibernate in the larva state. A case opened at any time during the winter will be found to contain a short thick yellow larva differing considerably from the mining form. (A description of both forms will be found at the end of this account.) In this state the insect remains until some time in March or April, depending upon the severity of the season, when it transforms to the dusky yellow pupa. The moth issues a week or so after the pupa is formed. This season the first moth issued on March 16th; but that it was much ahead of its time was shown by the fact that not a leaf was to be seen upon the trees.

Food plants.—At various times during the summer this same species was observed not alone upon the apple, but upon several varieties of cultivated pear trees and upon Crataegus in the department grounds. In September they were found in great numbers in the leaves of wild cherry trees in an old cemetery at Alexandria, Va.

Natural enemies.—Many of the cases were found in the webs of nesting spiders, upon different parts of the trees, but whether the spiders feed upon them or whether the case would protect them it is hard to say. The moths, however, would probably be unable to issue from the cases thus caught.

Large numbers were destroyed by ants. I have repeatedly observed two or more ants take hold of a case on opposite sides and tear it open, either devouring or carrying off the inclosed larva or pupa.

Two hymenopterous parasites have been bred from the cases of the resplendent shield bearer, the one a Microgaster, in large numbers, and the other a Chalcid in but a single instance.

Remedies.—Obviously the only remedy for this insect, when its injuries have become severe enough to attract attention, is to destroy the cases in the winter time. The bark of the tree can be slightly scraped and many thus destroyed, or it can be painted over with some insecticidal solution. A mixture of kerosene and water in the proportion of about 3 to 100 by volume, put on with a whitewash brush or sprayed from a fountain pump, would probably prove efficacious. A mixture of lime and sulphur in the proportions of one-half bushel shell lime to six pounds powdered sulphur, dissolved and brought to the consistency of a whitewash with hot water, was applied to the trees in the department grounds last fall. It had the effect of killing all of these case bearers which it reached, and undoubtedly destroyed all of the woolly apple lice (*Eriosoma lanigera* Hausmann) which were above ground, as well as all the bark lice (*Mytilaspis pomicorticis* Riley) which it touched. It is also claimed for this mixture that it has a beneficial effect in warding off the so-called "blight."

These remedies can, however, simply aim at a greater or less reduction of the numbers. Nothing like an extermination can be hoped for

unless through parasites, owing to the numerous food-plants of this insect. No matter how the work of destruction is performed upon the apple, the trees will be restocked from the wild cherry or some other plant difficult to reach.

We append a description of the larva and chrysalis, and quote Dr. Clemens's description of the adult, to enable readers to recognize the insect.

ASPIDISCA SPLENDORIFERELLA Clem.

Adult.—Head golden. Antennae fuscous, tinged with golden. Fore-wings, from the base to the middle, leaden gray, with a splendent lustre, and from the middle to the tip golden, with a broad, nearly straight, metallic silvery streak extending from the costa near the tip to the middle of the wing, and dark margined on both sides. This is nearly joined by a dorsal streak of the same hue almost opposite to it, with converging dark margins, and with a blotch of dark-brown scales adjoining it behind. In the costo-apical cilia is a short, blackish-brown streak parallel to the dark margin of the silvery costal streak. At the tip is a black apical spot, with metallic silvery scales in its center, and a few silvery scales in the cilia above and beneath it. A blackish-brown hinder marginal line in the cilia, interrupted by a silvery streak in the cilia beneath the apical spot, and the cilia yellowish-brown. Hind-wings leaden gray; cilia yellowish-brown.

Full-grown mining larva.—Length 3^{mm} (.12 inch). Head small, short, oval, retractile. First thoracic segment twice as wide as head; widest behind, rounding to base of head. Second thoracic segment wider than first, but only two-thirds as broad. Third thoracic segment narrower than second; succeeding segments gradually diminishing in size. General color light yellowish-brown. Head dark; first thoracic segment with a broad brownish disk, leaving a narrow yellowish band around border; second and third thoracic segments each with a similar brown disk, with two large transversely-oval yellow spots; abdominal segments 1 to 6 have each an irregular brown spot in the middle. No true legs present. The oval yellow spots on the second and third thoracic segments are cup-like depressions, dorsal and ventral, which aid in locomotion. There are also strongly-marked integumental folds laterally and at the anus, which act as prolegs. Projecting laterally from each of the thoracic segments are four hairs, two on each side; and from each abdominal segment except the last, one projects on each side. Around the anus there are ten hairs, each springing from a small tubercle. Joints of segments quite strongly marked. Upon the ventral side of the prothoracic segment is a transverse slightly recurved row of from twenty to twenty-five small pointed tubercles.

Hibernating larva.—Length 1.7^{mm}; width .7^{mm}. Broad, stout, sides subparallel; ends subequal. Head entirely retracted in prothoracic segment. Distinction between segments not nearly so marked as with mining form. General color rich straw. The only marking is a narrow brown curved line on the under side of the prothoracic segment. No lateral hairs observable.

Chrysalis.—Length 1.5^{mm}. In profile the venter is straight and the dorsum considerably arched. Wing-sheaths and posterior tarsal sheaths extending to end of abdomen. Antennal sheaths short, ending nearly even with anterior tarsal sheaths. Head more elongated and more strongly differentiated from thorax dorsally than is usual. No spines of any kind observable. Color: Abdomen light-yellow, blackish at anus; eyes large and black; wing-covers, leg and antennal sheaths, dorsum of thorax, and head smoky, darker on forehead than elsewhere.

THE GRAPEVINE FLEA-BEETLE.

Graptodera [*Haltica*] *chalybea*, Illiger.

Order COLEOPTERA; family CHRYSOMELIDAE.

Eating into the buds in early spring, and, later, gnawing holes into the leaves, a small steel-blue jumping beetle. In May and June the brown sluggish larvae upon the upper surface, also eating irregular holes, and frequently skeletonizing the leaf.

So much injury has been done by this celebrated pest during the past season, and so little seems to be known concerning its habits amongst those of our correspondents who have been the worst afflicted by it, that we feel constrained to give in brief a resumé of its natural history, fig-

uring it anew in all stages, and giving such advice as we may be able in the shape of remedies. (Plate III, figs. 1, 2.)

The grapevine flea-beetle was first described in 1807, by Karl Illiger,* from specimens labeled Georgia and Pennsylvania. Its transformations were first set forth by David Thomas, in Silliman's Journal, vol. xxvi, from observations made in Central New York. Nearly all the subsequent writers upon economic entomology have given it greater or less mention.

The greatest damage which is done by the flea-beetle is, perhaps, the eating of the vine buds early in spring. The adult beetles hibernate in great numbers under the rough bark of the supporting posts, under the outer bark at the base of the vines themselves, in the joints of neighboring fences, under sticks, stones, or logs upon the ground, in any crevice, in fact, which will afford them shelter. During the first warm days of the spring, as the buds are beginning to swell and burst, these pests leave their winter-quarters and, in the middle of the day, when the sun is shining brightly, fly or jump to the nearest vine. They then gnaw unsightly holes into the opening buds, often boring in so far that they are almost hidden from view. In a vineyard of many acres we have seen dozens of buds upon every vine thus destroyed.

The beetle is small, measuring only from 4 to 5^{mm} (less than one-fifth of an inch) in length. Its color is dark steel-blue, varying occasionally to purplish or even brown. The characteristic which is at once noticed, and which has gained it its popular name, is its power of jumping like a flea. For this purpose its hind thighs are much enlarged. Like many others of its family (*Chrysomelidae* or leaf beetles), it has the habit of feigning death when disturbed, and will jump or drop from a vine upon which it is at work if the vine be shaken. After their first hunger is satisfied the beetles pair, and, as soon as the leaves have become unfolded, the females begin to deposit their eggs.

The eggs, which are a long oval in shape, measure on an average $.65^{mm}$ (.03 inch) in length. They are straw colored, and are laid in irregular clumps of four or five, more or less, both upon the upper and under sides of the leaf. Rarely a few eggs are to be found upon the unopened buds, and the beetles, if caught early in the season and kept in confinement, will oviposit profusely upon any substance whatsoever. Some time in May, the date varying considerably, the young larvae hatch from the eggs. They are dark brown in color, and have six large thoracic legs and one anal proleg. They feed usually upon the upper side of the leaf, eating irregular holes through, and gradually skeletonizing it down to the main ribs. It requires, in this latitude, from three weeks to a month for them to attain full growth. With an insect which has such a wide northern and southern range as this it is impossible to make any definite statements with regard to length of stages or even number of broods. As an example of this we may refer to the letter of Mr. W. F. Parker, of Tebeauville, Ga., quoted later, wherein he states that the young larvae were at work on his vines March 15.

The full-grown larvae (Pl. III, figs. 1 and 2) are lighter in color than are the young, being of a chestnut brown, and are paler below than above. Their average length is 6^{mm} (.234 inch). Each segment above has two transverse rows of six black spots, each spot giving rise to a hair. The thoracic legs are dark brown, and the anal prop leg is yellowish. When they have fed sufficiently the larvae drop from the vines, and, after working their way for a short distance under ground (two or three inches) they form a smooth cavity around themselves and transform to pupae.

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* *Illiger's Magazin für Insektenkunde*, vol. vi, p. 115.

The pupæ are about 4^{mm} (.15 inch) in length, and are yellowish brown in color. In this state they remain from two to three weeks, when the perfect beetles emerge. It has been universally stated by authors that this is the only brood which is produced in the course of the year, but we surmise that a second brood will yet be found, particularly in the more southern States, where the insect completes its tranformations as early as the first of May. The newly developed beetles feed upon the leaves as did their predecessors; and, although their injuries are not usually so marked as are those of the hibernating individuals, owing to the more advanced state of the foliage, still we have heard reports of considerable damage done by them.

There is no way, so far as we are aware, of getting rid of this pest without considerable hard work. In the first place, much should be done in the late fall, winter, and early spring, in the way of finding out and destroying the hibernating places of the beetles. It has, unfortunately, been the custom quite generally to train the vines in extensive vineyards to posts from which the bark has not been removed. This bark cracks and peels and thus affords most excellent and convenient shelter to the beetles. In the large vineyard of Mr. A. R. Phillips, of Arlington, Va., we have the present season seen the saddest results from the use of posts of this kind. All loose bark and splinters should be removed from posts and trellises or other supports, and all rubbish in the vicinity raked up and destroyed. As an actual practical illustration of the amount of good which can be done in this way we can do no better than quote from a letter, dated March 15, from Mr. W. F. Parker, of Tebeauville, Ga.

During the months of December and January I went over the whole vineyard, skinning all the bark from the posts, most of which are cypress, trimming all splinters from the slats of which the arbors are made, taking care to remove all the wood that could be spared, and raked and piled up the mass, including all the leaves and other trash that was upon the ground, and burnt it. This process I repeated twice, each time killing the beetles. About the first of March my vines began to bud and put out fruit, and, upon close inspection, I found the beetle was ahead of me. There being but few of them I picked them off with the hand, watching, hunting, and catching them two or three times daily, and up to the tenth had killed, I suppose, about one hundred in all. I was not able to find one in the whole vineyard until the fifteenth, at which time I found three, and made the further discovery that some had escaped my eye and had been hatched out. On one vine I found, I suppose about fifty worms just hatched and boring the leaves. These I killed with the hand. I saw no signs of the worm on any other vine. Last March I suppose there were five or ten bushels of the pest.

Inasmuch, however, as a farmer is liable to wake up some fine morning and find his vineyard full of these insects, in a locality where they have been overlooked before, some remedy besides clean cultivation the previous winter becomes necessary. It has been found the present spring, by experiments in Mr. Phillips's vineyard, that they can be kept in check in the following way: A strip of cotton cloth, 3 by 6 feet, kept open by cross-sticks at the ends, is thoroughly saturated with kerosene and held under the vine, while the supporting-post is struck a sharp blow with a club. The beetles readily fall by the jar, and contact with the kerosene sooner or later destroys them. It will without doubt be found advisable to make use of two of these sheets in order that the vine may be more completely surrounded. With this simple apparatus three boys can go over a large vineyard almost as fast as they can walk; and if this be done every day, say for a week, in an infested field, the beetles will be quite thoroughly destroyed. After striking the saturated sheet the beetles show no disposition either to fly or to jump. When, however, they strike near the edge of the cloth, they not infrequently crawl

to the edge and fall to the ground, possibly reviving from the effects of the small dose. The escape of these individuals can be easily prevented by simply stiching a rim of raw cotton or cotton-batting to the sheet and thoroughly saturating it also with the coal oil.

Should so many of the beetles escape from the prosecution of this remedy that the injuries of their larvae become marked, or should the remedy be applied after the eggs have already been deposited, the larvae may be destroyed by syringing the vines with a solution of whale-oil soap (two pounds of soap to fifteen gallons of water) or by dusting lime upon the leaves, either by means of a sifter or by blowing it from a bellows.

No parasite has been discovered as yet upon this insect, but that they are attacked by a fungoid disease seems probable from the fact that specimens which Mr. Parker sent us, and which were found under the bark of the vines, were fastened to the bark and surrounded by a mass of white fungus spores.

THE ASPARAGUS BEETLE.

(*Crioceris asparagi* Linn.)

Order COLEOPTERA; family CHRYSOMELIDAE.

Gnawing holes into the young heads of asparagus, and laying oval black eggs upon them, a small red, yellow, and black beetle, the larvae of which (small, brown, slug-like grubs) also feed upon the young heads, and the second brood upon the full-grown plant. (Plate III, fig. 4.)

The asparagus crop, in Europe, has long suffered from the attacks of several insect enemies, the most noted of which is the one above mentioned. On this side of the Atlantic, however, asparagus had always enjoyed perfect immunity from insect ravages until, in 1859, this European pest was accidentally introduced in the vicinity of New York City. It almost immediately spread out into the noted asparagus beds of Queens County, Long Island, and by 1862 had multiplied to such an extent as to occasion a loss of over one-third of the crop in some localities. In this year it first attracted the notice of Dr. Fitch, and his observations are published in the Transactions of the New York State Agricultural Society for 1862. Since that date the insect has been spreading slowly eastward on Long Island, northward in Connecticut and New York, and westward and southward in New Jersey and Eastern Pennsylvania.

The past season the worst reports of its injuries have come from Burlington County, New Jersey, which locality it reached for the first time in 1878, and in 1879 a correspondent, writing May 15, said: "Twenty-five per cent. of the market crop of Burlington County has already been destroyed."

The life history of the asparagus beetle is briefly as follows: Upon the appearance of the plants in early spring, and just before the cultivators are ready to begin bunching for the market, the beetles come forth in great numbers from their hibernating quarters—under sticks, stones, rubbish, and especially under the splinters of wood on fences, under the scaly bark of trees—and commence gnawing the tops of the young plants. They pair and lay their eggs very soon. The eggs are a long oval in shape, about one-sixteenth of an inch in length, and are nearly black in color. They are invariably placed endwise upon the plant, as shown in the figure. (Plate III, fig. 4.) They are usually seen

in rows of from two to seven. In from seven to ten days the young larvae begin to make their appearance. In form they bear a close resemblance to the Colorado potato beetle larvae, but differ in coloration. The general color is grayish olive, with shining black head and brown legs. When full grown they measure about 8^{mm} (a little over three-tenths of an inch) in length. Concerning the habits of the larva we quote from Fitch:

> Like the perfect insect, the larva feeds upon the asparagus only, eating holes through the outer bark of the plant and preferring the tender bark on the ends of the stalks and on the branches to the more tough and stringy bark towards the base of the stem. It moves very slowly and is shy and timorous. As you approach it, it stops eating and holding its head stiffly back it emits a drop of black fluid from its mouth. This appears to be its only defense against being devoured by birds and other predaceous animals, the acrid taste of this fluid probably rendering the larva unpalatable to them. It also clings tenaciously to the asparagus. Before tying the cuttings up in bunches for the market they are thoroughly washed by being held usually under a pump; but these worms cling so tightly that only a part of them are washed off, and this black fluid from their mouths stains and nasties the hands of the men, in bunching the cuttings, it being as sticky as molasses.

Under ordinary circumstances the larva attains its full growth in from ten to twelve days; then, descending to the earth, it either burrows for a short distance or crawls under some rubbish, and, after spinning a slight cocoon, transforms to a pupa, in which state it remains, on an average, for ten days.

The perfect beetles are as beautiful insects as one can readily find. The head, antennae, legs, and under side of the body are shining black, with a slight tinge of metallic green. The thorax is reddish-brown, with two black marks in the center. The wing-covers are light-lemon yellow, with a longitudinal black stripe down the center and a transverse black band at its middle; also an irregular black spot at each corner, and a border around the whole of orange-yellow. The average length is about 6 or 7^{mm} (about a quarter of an inch). The form can be seen in the plate. They are very shy and active, and will dodge around the stalks upon being approached. Like nearly all other leaf beetles, they drop from the plant when disturbed and feign death. There are several broods in the course of the season, the confusion of generations making it difficult to state just how many. The insects hibernate, as we have before stated, as adult beetles, under whatever shelter they can find.

REMEDIES.

The only method used in Europe by gardeners to rid themselves of this pest seems to be hand-picking; but this of course can only be done effectually where asparagus is cultivated on a small scale. The only remedy which Fitch was able to suggest was turning poultry into the beds where the insects were at work; this he thought would prove effectual. At the time of the first introduction of the pest, experiments were made with potash solutions, salt, lime, and other substances, but without good results. The last-named substance, however, seems to have grown in favor of late. Mr. A. S. Fuller, of Ridgewood, Bergen County, New Jersey, has recently published an article in the American Entomologist, in which he says:

> Lime is not only a very cheap and effectual cure for the evil, but one readily obtained in all parts of the country. With a pail full of dry lime and an old broom for a duster, or one of the sifters used for applying Paris green to potatoes, a man can soon go over an acre of asparagus. The best time to apply the lime is in the morning while the dew is on, for then a portion will adhere to the plants as well as to the grubs, and during the day or days following it will be constantly dropping down, or blown about

among the leaves and branches, thereby making the escape of any larvae all the more uncertain. The lime is also beneficial to the asparagus roots, hastening the decomposition of the manure usually applied in large quantities to the beds. For the past sixteen years I have used lime as described on my asparagus beds, to keep the insect in question in check, and it has done it so effectually that about one application every alternate season has been sufficient.

The New York Tribune has the following in reply to queries respecting this insect:

Experience shows that it will not harm the roots of the plant to cut off and burn the tops before or at the time of blossoming. In fact one remedy that has been used with success is to cut down in spring all the plants upon the farm that are not used or intended for market, hoeing up the young seedlings that, as is well known, annually start in the beds from the last year's seed. By this method the mother beetle is forced to lay her eggs upon the large shoots from the old stools; and as these are cut and sent to the market every few days, there are no eggs left to hatch out into larvae for the second brood of beetles. By concerted action in following out this plan, this insect could be kept in check. In those localities where asparagus has run wild it would be necessary to destroy the wild asparagus also. In case the plants have been allowed to grow up the larvae may be controlled by dusting lime over the plants when these are wet with dew and while the larvae are young. Lime has but little effect upon the perfect beetle, and its use early in the season, when the first brood of beetles is about, is objectionable from the fact that it soils the marketable stalks. The first remedy is, therefore, by far the best.

Recent communications from Messrs. Valentine Frost, and S. S. Underhill, of Locust Valley, prominent Queens County, Long Island, asparagus growers, confirm the practicability of the first remedy mentioned in the above quotation, namely, destroying all so-called "volunteer growth," and forcing the mother beetle to lay her eggs only upon the market shoots which are cut frequently enough to prevent the eggs from hatching. Should any escape this method and hatch, Mr. Underhill advises going over the field in the heat of the day and brushing the worms from the plants with a leafy twig. They fall to the hot ground and generally perish. This is advised in preference to the lime dusting. According to Mr. Frost, experiments were made some seasons ago with the lime, but no apparent good being accomplished, it was discontinued.

THE MELON-WORM.

(*Phakellura hyalinatalis* Linn.)

Order LEPIDOPTERA; family PYRALIDAE.

Eating cavities into melons, cucumbers, and pumpkins at all stages of growth, and also devouring their leaves, rather active yellow-green larvae from 30 to 35^{mm} (1¼ inch) in length. (Plate III, figs. 5, 6.)

Phakellura hyalinatalis has long been well known to entomological collectors from its beauty and abundance in certain localities; but has received almost no attention from economic workers. Guenée speaks of it as one of the most abundant of exotic Pyralids, and, in giving its geographical distribution, says: "Very common in all America. I have received it from Brazil, from Colombia, from Hayti, from North America, and from French Guiana." Certain authors are inclined to think that it may also be found in Europe, and Stephens states that it has actually been captured in Devonshire near Plymouth, but Guenée considers this an accidental introduction, and thinks that it cannot be considered as an European species.

As to the food plant of the larva Guenée simply states that it lives upon the pumpkins, watermelons, and other cucurbitaceous plants.

In the July, 1875, number of Field and Forest a short account is given

of the destruction of a large crop of cucumbers at Indian River, Florida, by these worms. It was stated that they first attacked the bud, then worked into the plant, and eventually killed them out, root and branch. Beyond this we have seen no account of much damage by this insect.

During the past summer, however, the melon crop in parts of Georgia has been very seriously injured by its ravages; to what extent is vividly shown in the following account which was kindly written at my request by Prof. J. E. Willet, of Macon, Ga. I have headed this article "The Melon-Worm" in spite of the fact that this title is not sufficiently distinctive for a popular name, for the reason that this insect is already generally known by that name among those who have suffered from its work.

Professor Willet's account is as follows:

At the annual meeting of the Georgia Horticultural Society, July, 1879, earnest inquiry about the melon-worm was made by many of the members. It was stated that the August crop of musk-melons was very subject to the attacks of worms, which were very numerous and destructive, and against which no remedies had been successful.

The only worm destructive to melons, described in the books at my command, was the pickle-worm, *Phakellura nitidalis*. The figures and description of this by Prof. C. V. Riley are copied by Professor Packard in his Report on Noxious Insects in Hayden's Report for 1875. This worm is there represented as very injurious to melons, cucumbers, &c., in the Western States. A moth of this species was caught in my house the last week in August, and was the only one seen during the season.

On the same day on which this moth was caught Mr. S. I. Gustin brought me two nutmeg-melons, saying that they were the best of a load which he had just gathered. Each melon had about half a dozen caterpillars, which had excavated shallow cavities in the melons, or had penetrated bodily into the same. The melons were too much injured to be eatable. These worms, I naturally supposed, might be the pickle-worms, a moth of which species I had just caught.

In the course of the next two or three weeks I visited three melon patches, where musk-melons had been planted for market. All presented the same scene of total destruction. Most of the vines had been more or less denuded of leaves, and the remains of the leaves contained brown chrysalids or *pupae* "webbed up" in them. The melons of various sizes, were occupied in great measure by the worms. The younger worms were generally confined to the surface, but the elder had penetrated to different depths. Some had excavated shallow cavities half an inch to an inch in diameter, and one-eighth of an inch in depth; and each cavity was occupied by one or more worms. Others had penetrated perpendicularly into the melons, frequently beyond sight. None had reached the hollow of the melon, so far as I saw. The worms averaged probably half a dozen to each melon. The melon crops of these three market-gardens were a total loss. Another gardener told me that he had abandoned the culture of melons entirely, because of the ravages of the melon-worm. Where cultivated in considerable numbers, the August and September crop of melons is very uncertain. The destruction is frequently quite as complete, also, in private gardens.

The melon-worms are of a light yellowish-green color, nearly translucent, have a few scattered hairs, and, when mature, are about an inch and a quarter in length. They "web up" in the leaves of the melon, or of any plant growing near which has flexible leaves, forming a slender brown chrysalis three-quarters of an inch in length. Hundreds of these pupae were found rolled up in the leaves of the tomato and of the sweet-potato.

In passing through one of the patches referred to, numbers of small, beautiful moths rose from the grass and weeds. Their wings when extended measured an inch across, and were of an iridescent pearly whiteness, except a narrow black border. Their legs and bodies presented the same glistening whiteness, and the abdomens terminated in a curious movable tuft of white appendages like feathers, of a pretty buff color, tipped with white and black. These moths proved to be the mature melon-worms, which had emerged from the chrysalids referred to.

The melon-worms, larvae chrysalids, and moths, were forwarded to Prof. J. H. Comstock, Entomologist of the United States Agricultural Department, for identification. He pronounced them to be *Phakellura hyalinitalis*, another species of the same genus as the Western pickle-worm, *Phakellura nitidalis*. The moth of the latter, which I have, is somewhat smaller, and the ground color of the wings is a bronze yellow and the black border is broader.

Much later in the season a few worms were found on cucumbers, and were pronounced by Professor Comstock to be melon-worms. A year previous, in the summer of 1878, I found a chrysalis webbed in a tomato leaf, and this chrysalis gave forth the

same moth, as was found in 1879 to issue from the melon-worm chrysalis. This worm had probably fed on the foliage of a pumpkin vine which ran near the tomato plant.

The melon-worm, *Phakellura hyalinatalis*, is known then to destroy musk-melons, cucumbers, and pumpkins. Its cousin, the pickle-worm, *Phakellura nitidalis*, has been found here, but it remains to be determined whether it plays any part in the destruction of melons or of cucumbers in this locality.

No efficient remedy for this pest has been discovered here. Some have tried placing each melon on a piece of plank, under the mistaken notion that the worms emerged from the earth. Paris green and London purple are objectionable, by reason of their poisonous properties. Professor Comstock has suggested to me a trial of the Persian insect-powder, pyrethrum. Whatever remedy is employed it must be applied to the leaves as well as to the melons. The worms devour both foliage and fruit, and, if the fruit alone be protected, the foliage will be destroyed, the plants will cease to grow, and the melons will not come to maturity.

J. E. WILLET.

MACON, GA., *May* 1, 1880.

The number of broods in a season has not been definitely ascertained. The insect winters in the chrysalis state, spun up in the leaves of any neighboring tree or plant. They usually migrate to a greater or less distance from their feeding place before webbing up. At Rock Ledge, Fla., I found them abundantly webbed up on Palmetto and Orange trees in a grove in which the so-called Indian pumpkins had grown.

As regards remedies Mr. J. S. Newman, of Atlanta, Ga., states that the only one known to him is to plant early, the object being to pick the melons before the most destructive brood of the worms has appeared. It would undoubtedly be found profitable to keep a sharp lookout for the *first* brood of the worms, which will probably be found feeding upon the leaves and stems before the young melons have begun to form. These should be killed by hand. This could be readily done in patches comparatively small in size, and we think will be found profitable in large gardens.

Two species of parasitic insects have been reared from the specimens sent to the department; one is *Pimpla conquisitor*, an Ichneumon-fly, which has proved very efficacious in the case of the cotton-worm; the other is a Tachina fly, and is represented in Pl. III, fig. 6. Much is to be expected from the aid of these parasites.

THE JAPAN LILY APHIS.

(*Siphonophora lilii*, Monell [new species].)

Order HOMOPTERA; family APHIDIDAE.

Feeding upon the under sides of the leaves of the Japan lily and tulip, a red and yellow aphid 2^{mm} ($\frac{1}{12}$ inch) in length.

In July, 1879, specimens of a handsome aphid were received from Mr. Peter B. Mead, of New York City, who had studied them for some time upon the Japan lilies in his green-house. The following notes upon habits accompanied the specimens:

I first noticed this aphis in the spring of 1878 on some Japan lilies, the bulbs of which, as well as the earth in which they were grown, were received from Japan during the preceding winter. My attention was first attracted by an unusual appearance of the under surface of the leaves, which looked as if thickly dotted with small brown specks. A closer examination proved them to be plant lice of a species entirely new to me. They were about half grown, but very soon attained maturity. Thickly grouped together on the leaves, they certainly presented a picturesque appearance, being the only aphis I have ever seen that could be called handsome. They multiplied with astonishing rapidity, and soon covered the plants. I am confident that they increase more rapidly than the green aphis. When disturbed they all seem to unite in a swaying motion, more marked than that of the green aphis.

Notwithstanding their great numbers, they do not injure or disfigure the plant to the same degree as other *Aphides*. At least this is the result of my observations thus far. If not disturbed, they literally cover the whole plant, buds and all. They seem thus far to confine themselves exclusively to the Japan lily, with but one exception. I have repeatedly examined all my other garden and pot plants, both last summer and this, without detecting this aphis on any of them, except a few on the tulip.

After watching them for a few weeks last summer I began their destruction; but in September they all suddenly disappeared without further effort from me. Whether they will do so this year remains to be seen. During the winter a very few made their appearance on a tulip in the green-house, but were immediately killed, and no more were seen.

In consequence of the cold and backward spring, they made their appearance quite late this year (1879). At the time of writing (July 26) they cover the plants on which they have not been disturbed; but, as was the case last year, they are confined exclusively to the Japan lilies. I have traveled about not a little, but have failed to discover this aphis, except in one place, which I can trace immediately to my own plants, or, more strictly, to the same lot. Hence I conclude that it came from Japan with the lilies or the soil.

Specimens were sent to Mr. Monell for identification. He considered it to be a new species of the genus *Siphonophora*, and forwarded the following specific description for insertion in this report:

SIPHONOPHORA LILII (n. sp.)

General color yellow; basal half of abdomen brownish red. Antennae mounted on conspicuous tubercles. Style yellow, a little over half as long as the nectaries. Nectaries dusky, yellowish just at base, about four times as long as the tarsi. Venation normal. Length 2^{mm}. Alar expanse 7^{mm}. On flowers of Lilium.

The only other described Aphides on liliaceous plants are *Aphis tulipae*, Boyer de Fonscolombe, 1841, and *S. tulipae*, Monell.

It might be interesting to mention in this connection that on the allied family, the Amaryllidaceae, there have been found *Rhopalosiphum dianthi*, Schr., *Aphis veratri*, and *Aphis papaveris*.

THE HAWTHORN TINGIS.

(*Corythuca arcuata*, Say, var.)

Order HEMIPTERA; family TINGIDAE.

Puncturing the under surfaces of the leaves of different species of Crataegus, giving them a brown and sunburnt appearance, a small brown insect, with the hemelytra carried horizontally, and formed of a nearly transparent membrane netted with many stout veins; the immature forms spiny and wingless.

The leaves of the different species of thorn on the department grounds (*Crataegus cordata*, *C. coccinea*, *C. tomentosa*, *C. crus-galli*, *C. parvifolia*) toward the middle of the summer were observed to turn brown and seared, as if burned by the sun. Upon examining the under surfaces the explanation was readily seen in the large numbers of the bizarre Tingides in all stages, with which the under side was fairly covered.

The eggs of these insects, which, I think, have not been described, are smooth, whitish, glistening, semi-transparent, and ovoid in shape. Their average length is 3^{mm} (.01 inch). They are deposited on their broad end, and seem to be somewhat inserted into the substance of the leaf; they are covered completely by a brown, sticky substance, which hardens soon after oviposition. It adheres so firmly to the egg, especially to the upper portion, that it is impossible to remove it without crushing the egg. At its upper end this covering of the egg is squarely truncate, giving the whole mass the appearance of a frustum of a cone with a porous lid. From the funnel-shaped summit the young insect makes its exit, and the round hole at this point renders the empty eggs readily distinguishable from those still unhatched. The eggs are usually laid, in groups of from ten to thirty, along both sides of some prominent leaf vein. They bear a much greater resemblance to certain forms of

fungi, notably the genus *Phoma*, and to certain young homopterous galls, than they do to eggs of any sort. (Plate III, fig. 3.)

The immature insect is of the same dirty brown color as the substance covering the egg, and but little darker than the withering leaf. It is of a broad, flat, oval shape, and spines seem to project from almost every portion of its body. It looks under the microscope more like a lobe of a prickly cactus than anything else we can think of. The cast-off skins stick to the leaf, and give it the appearance of being much more seriously infested than it really is.

The general appearance of the mature individuals is well shown by Plate IV, fig. 2. Their average length is about 3^{mm}. Professor Uhler, in his note determining the species, said:

> Your specimens of Tingis belong to the genus *Corythuca*, and seem to be a new phytophagic form of *Corythuca arcuata* Say. It will hardly do to make a new species out of this insect, as it is one of the several forms which fit into Say's species. It comes near to the race belonging to the *Juglans nigra*.

The dead leaves under the bushes during winter have been often found to contain living and healthy eggs of the Tingides; but the customary method of hibernation is in the adult state alone. This form can be found during winter under the loose bark of the tree, and under sticks and stones upon the ground. Whenever the injuries of these insects become so great as to render some remedy necessary, syringing with kerosene and water, in the proportion of 1 gill of the former to 5 gallons of the latter, will be found to answer the purpose. It is fair to suppose, however, that if the leaves and rubbish underneath the trees are destroyed, either every fall or every spring, a necessity for remedies will not arise.

THE LOCUST SAW FLY.

(*Nematus similaris* Norton [new species].)

Order HYMENOPTERA; family TENTHREDINIDAE.

Eating the leaves of black locust, a small, soft, green worm, with 20 legs and apparently many segments. (Plate IV, fig. 1.)

The life history of an interesting saw fly, the larvae of which have been found in considerable numbers feeding upon the locust trees (*Robinia pseudacacia*) of the District, has been studied during the past season.

The egg, which is .5^{mm} (.02 inch) long, white, semi-transparent, and in shape resembles an irregular semi-ellipsoid, is deposited in a crescent-shape cut made in the under surface of the leaf by the saw-like apparatus of the female, never, so far as I am aware, near the rib. The egg being deposited, the flap made by the crescent cut is forced upwards, making a protuberance which is readily observable upon the surface of the leaf, and which is also increased by the swelling of the egg. The time required for the development of the egg is short, only a few days elapsing between the depositing and the hatching.

The newly-hatched larva is pale-greenish white with a brownish head. It has twenty legs, six large thoracic, twelve abdominal, and two anal. It moves a short distance from the place of its birth and commences feeding on the lower surface of the leaf. At first a round hole is eaten in the leaf; as soon as this is sufficiently enlarged the larva works within it, holding its prolegs along the cut edge, as shown in the figure. As it grows larger the larva frequently leaves the partially destroyed leaf and migrates to another; this one, however, it begins to eat on the edge, and

usually destroys entirely. A number are thus ruined by a single larva. The method of work and the attitudes assumed by the larvae are well shown in the figure. When disturbed, or upon being touched, they raise the abdomen and strike with it violently from one side to the other, the end of the body swinging around as far forward as the head, which it frequently strikes. While making this violent motion they must necessarily cling very firmly to the leaf with their thoracic legs, and indeed it is difficult to remove them without injury.

The full-grown larva is of a uniform green color; the head is yellowish-green; the eyes black, with pale centers; and the stigmata pale, surrounded with a brownish ring. Upon abdominal segments 1 to 6 there is seen below the stigmatal line a dusky spot, which, upon examination with the lens, is seen to consist of two swellings, each with three dusky warts, surmounted by a single hair, and a conical tubercle which bears no hair. Above the anus there is a pair of short, thick, club-shaped tubercles. From the habit of the larva, just described, of striking with its posterior end, it would seem possible that these tubercles might emit some offensive fluid, although they have not been observed to do so. At full size it is from 10 to 12^{mm} long ($\frac{2}{5}$ inch).

When it has ceased feeding the larva drops to the surface of the ground, and there, amongst the leaves, grass, or other rubbish, spins itself a tough, coarse, and rough oval dark-brown cocoon. In this it remains for several days before transforming to a pupa, and issues as a perfect insect in from two to three weeks after the commencement of the cocoon.

The cocoons, although made upon the surface of the ground, are very difficult to find on account of their brown color and the adhering particles of earth and dead vegetable material.

The adult insect is 6^{mm} long (nearly $\frac{1}{4}$ inch). Its general color is dirty yellow, with a squarish black patch on top of the head; the lateral and anterior lobes of the thorax black; and a transverse black patch on top of each abdominal segment. The under side of the body is yellowish; anterior and middle legs yellowish; tibiae and tarsi of posterior legs nearly black. The antennae are half as long as the body, 9-jointed; the first and second joints very short; the third joint longest—as long as fourth and fifth together; other joints decreasing in length. The stigma, or dark spot at the anterior border of the wings, is yellowish-brown, nearly black at its basal half. The wings expand 15^{mm} (.59 inch).

There are two and possibly three broods in a season. The first larvae were not noticed until August 30, and were nearly full grown. They spun up September 6, and issued as adults September 24. The first week in October other adults issued from their cocoons. October 2 larvae were still found in all stages of growth. October 10 a search for cocoons upon the surface of the ground under the trees revealed the fact that all that could be found were empty. This demonstrated one of two things, either that the insect customarily hibernates as an adult, or that the cocoons found were all of the earlier brood, and that the hibernating cocoons were to be found in securer quarters, say under the ground. In either case the hope which we had gained from the habits of the earlier brood of an easy method of extermination by burning the rubbish on the surface of the ground during winter was thwarted. As to the usual method of hibernation, we were forced to believe that it is double, either as adult or as pupa. As just stated, perfect flies were issuing in the breeding cases in October; while, on the other hand, one larva, which spun up September 25, did not issue as a fly until March 2, while another, which spun up September 30, only issued March 23.

The amount of damage done by these worms at times must be considerable. Mr. Norton states that the larvae of *N. trilineata* occur in enormous numbers occasionally upon the weeping willow, sometimes wholly stripping large trees of their leaves. Although the amount of damage done to the locusts in this vicinity the past season was not such as to materially injure them, still we may expect such injury any season.

In case of their appearance in destructive numbers they can probably be kept in check by syringing the trees with a whale-oil-soap solution, thrown by a garden syringe or a fountain pump, where it can be used with safety. Paris-green water will be found an effectual remedy.

An ichneumonid parasite has been bred from the cocoons of this Nematus, and was determined by Mr. Cresson as *Phygadeuon pubescens* Prov.

Specimens of this saw fly were referred to Mr. Edward Norton for determination. Mr. Norton decided that they represented a new species, of which he furnishes the following characterization:

DESCRIPTIVE.

NEMATUS SIMILARIS Norton (n. sp.).

Color reddish yellow; a spot on head; three vittae on thorax; bands on tergum, and hinder tibia and tarsi black.

Size of N. integer.—♀ Antennae about two-thirds the length of body; the first and second articles very short, the third, fourth, and fifth longest, subequal, black. Color of head and body reddish yellow; face below the antennae whitish; a square black spot on occiput, extending to back of head and extending down the ridges of basin before; head wider than thorax; pro and mesothorax black, with the sutures paler, and a more or less distinct V on prothorax; scutels pale—basal plates and a band on each segment of tergum black; ovipositor sheathes black, a small dark spot below the anterior wings; legs yellow—paler about the trochanters; the anterior tarsi blackish above; the hinder tibiae and tarsi black, with their tips pale; wings hyaline—emarginate at costa; nerves black, about the costa brown; basal half of costa clouded.

♀ Three females.—This belongs to the group of *N. integer*, S. pomum, hospes, &c., which are so much alike, and at the same time so variable in the amount of black, that the comparison of a large number of specimens and study of their larva is needed to distinguish them.

THE LESSER LOCUST LEAF GELECHIA.

(*Gelechia robiniaefoliella* Chambers [new species].)

Order LEPIDOPTERA; family TINEIDAE.

Spinning two locust leaves together and feeding between them, leaving the outer surface and the larger ribs untouched, a minute, greenish white slender larva, which transforms to a chrysalis in the same situation.

To the list of insects injurious to the black locust, given by Mr. Chambers in a recent number of the American Entomologist (vol. iii, No. 3), we have to add a new species of Tineid, which we call the Lesser Locust Leaf Gelechia, in contradistinction to *Gelechia pseudacaciella* Cham., which has very similar habits, but which is considerably larger. (See notes of the year.)

The small light-green larvae of the species under consideration were first noticed in the latter part of August. They were invariably found, each, between two leaves which had spun together, eating the surfaces thus inclosed, but not eating through to the exterior surface. From this time up to the middle of October, when the leaves were fast falling, larvae, evidently of the same brood, were at work. Some had already

begun to transform by the middle of September, others not until a month later. As a preparation for transformation a silken lining was simply spun between the leaves already webbed together, and in that the last larval skin was shed, the chrysalis falling to the ground with the falling leaves. In the warm room in which the breeding cages were kept the moths began to issue about the middle of December, and were continually issuing from that time until spring. Under ordinary circumstances they probably do not emerge until spring.

We have not observed the eggs and newly-hatched larvae of this insect, but the former are probably deposited upon the under surface of the leaf and the latter probably live at first in a slight web on the under surface of the same leaf, only attaching it to another leaf as it increases in size.

It will be an easy matter to destroy these insects, should they become so abundant as to necessitate some remedy, by simply burning the fallen leaves in late autumn.

We append to Mr. Chambers's characterization of the species, which follows, a short description of larva and pupa:

GELECHIA ROBINIAEFOLIELLA (n. sp.).

At first glance I inclined to think that the single female specimen from which I describe this species was either *G. obliquistrigella* Cham. or *G.* (*Sinoe*) *fuscopallidella* Cham., to each of which it bears some resemblance, being, however, nearer the latter. I think, on further examination, that it is distinct. If, however, it should prove to be *fuscopallidella* or a variety of it, then I wish to change the specific name of the latter to that above given, because, in conformity with the rule among the *Tineina*, it should receive its name from its food plant, and *robiniaefoliella* is, for other reasons, preferable. Though the larva feeds on the locust, the moth cannot be mistaken for *Anacampsis robiniae* Fitch, a species known only by Dr. Fitch's description, which is evidently made up from the larva, mine, and moth of two, if not three, very different genera and species, the mine described by Dr. Fitch being that of *Lithocolletis robiniella*, the larva that of *L. ornatella*, and the moth either *Gracilaria robiniella* or some utterly unknown species.

In this species the *palpi are slender and rather long and the hind wings are emarginate beneath the apex.* The palpi are white, with two dark brown annulations on the third joint and two brown spots on the outer surface of the second joint; face white, faintly irrorate with fuscus. Antennae brown; thorax and fore wings grayish fuscus, darker towards the apex of the wings; base of the dorsal margin of the fore wings fuscus with an oblique brown streak of slightly raised scales at about the basal fourth, pointing obliquely backwards towards a small brownish spot about the middle of the dorsal margin; the extreme base of the costal margin is brown, and before the cilia there is an oblique brown costal spot or streak. Hind wings and the cilia of both pair pale fuscus. Abdomen grayish fuscus; anal tuft straw yellow. Legs dark-gray brown, annulate with sordid white. *Al. ex.* ½ inch.

Larva.—Length, when full grown, 8^{mm} (.31 inch); slender, subcylindrical, tapering slightly at each end; 14 well-developed feet. Color, when young, a very light green; when full grown, considerably darker; when ready to pupate, with a pinkish tinge; head, pale brown; thoracic plate, faintly yellowish with brown edges. On each side ventral to the thoracic shield is a large, black, piliferous spot. On the dorsal surface of segments 2 and 3 is a slightly recurved transverse row of six piliferous spots, the dorsal pair being smallest and the subdorsal pair largest, each of the latter bearing two hairs. The abdominal segments have each four dorsal piliferous spots at the corners of a square and also the usual subdorsal and lateral spots. The anal plate is of the same color as the rest of the body, with a brownish posterior margin.

Pupa.—Length 4^{mm} (.15 inch), broad across shoulders and tapering acutely to anus; the anterior end being rounded. The general color is reddish brown. The whole dorsal surface is covered with numerous fine and regular punctures. The seventh abdominal segment has its posterior dorsal margin toothed and its ventral margin fringed with bristles. The anal joint has many minute slender hooked projections. The members are closely soldered together; the wing cases, antennal sheaths, and posterior tarsal sheaths all ending together at the posterior ventral margin of the fifth abdominal segment.

THE WHITE BLOTCH OAK LEAF MINER.

(*Lithocolletis hamadryadella* Clemens.)

Order LEPIDOPTERA; family TINEIDAE.

Making a whitish blotch mine upon the upper surface of the leaves of different oaks, a minute, flat, horny, footless, active, brownish-yellow larva, which transforms within the mine in a delicate discoid silken cocoon. (Plate IV, fig. 4.)

In the latter part of June, 1879, the leaves of many of the oaks on the department grounds were seen to be badly spotted by the mines of this interesting little insect. Although each mine by itself caused but an insignificant blotch, yet these insects were present in such enormous numbers as to promise serious injury to some of the trees. It is safe to say that with a few trees every leaf contained, on an average, four or five miners, and with many leaves the entire parenchyma on the upper side of the skeleton was entirely eaten out, leaving the upper epidermis as dry as parchment. The vitality of the tree had made efforts to repair the injury, but the constant drain upon the tree, supporting these hundreds of thousands of living beings, sadly weakened it before the end of the season.

Of American oaks the following species were affected: *Quercus lyrata*, *Q. prinus*, *Q. rubra*, *Q. tinctoria*, *Q. robusta*, *Q. panonica*, *Q. macrocarpa*.

Of foreign oaks growing upon the grounds the following had been attacked: *Quercus cerris*, of Southern Europe; *Q. robur*, of Great Britain; *Q. pyrenaica*, from the Pyrenees; *Q. aegilops*, from the Levant; *Q. sideroxylon*, of Mexico; *Q. daimio*, of Japan; *Q. sp.* from Japan.

The character of the mine varied more or less with the variations in size, pubescence, and thickness of the epidermis of the leaf. A leaf of *Q. lyrata*, for instance, when extensively mined, presents an entirely different appearance from a leaf of *Q. prinus*. Chambers states in general that the mine of *L. hamadryadella* is a "whitish blotch on the upper side of the leaf." Upon different species of oak, however, the color of the blister-like blotch caused by the mine varies from whitish through yellow to dark brown.

The upper epidermis of the leaf being removed and the bottom of the mine exposed to view. it is seen in every case to be curiously spotted with the excrement of the larva, as is well shown in the plate. The leaf therein represented is no worse affected than the average one upon many trees. Upon the under side of the leaves the evidence of the extensive mining upon the upper surface is usually very slight, and the most careful examination reveals only a slight discoloration.

Upon examining the edge of the mine with the microscope, usually one or more extremely minute eggs will be found, either empty or unhatched. These eggs average .112^{mm} in diameter (.004 inch), and are almost spherical in shape. They are tinged with brown before hatching, but after hatching are transparent. No markings are discernible.

The young larvae present a most curious appearance, as shown in figure *b* of the plate. They are nearly flat, with the first thoracic segment much larger than any of the others, the hind body tapering gradually to the end. The head is small also in comparison with the size of the first segment. As the larvae increase in size they still retain their flat form and as they approach full growth and have but one more molt to undergo they present the appearance of figure *c*. Upon the back of each segment is a shiny brownish horny plate, and the head and last segment are

dark. Although active while in the mine, only the faintest rudiments of legs are discernible. The mouth parts are very curiously modified. Mandibles and maxillae are the only parts to be seen, and they appear as figured at *d*. The mandibles seem admirably adapted for separating the leaf layers. Though apparently both mandibles are continuous, yet in reality they are simply connected by a membrane which allows play, and through an opening in which, on the ventral side, the food enters the alimentary canal. Two pairs of rudimentary almost colorless eyes can be seen under a moderate magnifying power, occupying the relative position indicated in figure *d*. The hind pair usually consists of four, five, or six large and apparently structureless cells, resembling fat cells. Each one of the front pair consists of from two to four similar cells though smaller. From the lateral edge of each segment projects a rather long bristle, and just above the lateral edge there is a smaller one. The last segment bears six such bristles. Between the lateral edge of each segment and its dorsal plate are two short, stout tubercles placed close together, and each surmounted by a short bristle. The spiracles are extremely minute, but with a high microscopic power can be seen near the latero-anterior border of each of the abdominal segments except the last, each with its minute tracheal branch running to it. The meta and mesothoracic segments have none, but that on the prothoracic is larger than any of the others and situated on the hind border of the segment.

When once removed from their mines these flat larvae have not the power to re-enter the leaf and commence new mines. This is due in great part to the peculiar structure of the mouth-parts, which are in no way fitted for piercing a tough epidermis. Then, too, as Mr. Chambers has suggested, the head projects straight forward and can be elevated or depressed but very slightly, which also is the case with the modified jaws.

To one acquainted with the general features of the larvae of the different orders of insects, these flat larvae bear a much closer general resemblance to coleopterous larvae than to lepidopterous. The number of molts which they have undergone up to this time is difficult to ascertain. Usually five cast-off skins can be readily found in a completed mine, which, together with the skin which is cast within the cocoon (of which we shall speak further on) and one or two small ones which have become so decomposed and mixed with the excrement as to have become indistinguishable, would indicate seven or eight molts. Mr. Chambers's studies have led him to the conclusion that there are always eight molts in Lithocolletis. He based this conclusion on the fact that eight distinct sizes are discernible in the larvae of each species. He has also noticed the following definite relation between successive molts: "At each molt except the seventh, the length of the larva in its first stage is added to that of the molting larva;" or, in other words, at each molt the larva increases in length by just the length of the first stage. I have been unable to verify this relation with the species under consideration.

When these flat larvae have attained full size they usually measure from four to five millimeters in length; and their blotch mine covers a space equal to from one-half to three-quarters of an inch square. At its seventh molt, instead of coming out again a larger flat coleopteriform larva, its entire appearance changes. It is longer than before, and, instead of being flat, is cylindrical. Its mouth parts have assumed a more normal lepidopterous form, and its eyes have become covered by dark pigmentary layer. The regular fourteen feet in the normal posi-

tion have appeared, the last pair or anal prop-legs alone varying from the usual form in being united across the middle line. The spiracles have become mounted on quite prominent tubercles, but their position is the same as in the flat form. The round larvae vary much in their markings. Some individuals have the brown, horny dorsal plates which were found upon the flat larvae; others have not a trace of them, while others still form various intermediate stages. The last four pairs of legs have the appearance of common prop-legs, but the first three pairs do not at all resemble the ordinary thoracic legs of caterpillars. Instead of being horny, articulated, and apparently ending in a point, they are mere fleshy tubercles, each with a depression in its center, and looking much like pro-legs.

The reasons for these remarkable changes are soon evident, for these round larvae are to spin the cocoon. With the mouth parts the now almost useless mandibles have become much smaller, and from being the most important have become the least important of the mouth parts. The parts appearing most prominently in the round form are the labium, bearing the spinnerets, the labial palpi, the maxillae and maxillary palpi, all of which help in the formation of the cocoon. The development of the feet is also necessary, as they enable the larva to turn itself readily in the narrow compass of the cocoon during the spinning.

The cocoon itself is simply a delicate, semi-transparent, circular sheet of white silk, stretched over a part of the bottom of the mine. It is usually from 5 to 7^{mm} (.2 to .28 inch) across, and is composed of delicate fibers running in every conceivable direction. The leaf at the bottom of the cocoon has a number of silken threads spun across it. The object of these threads is probably, as Mr. Chambers suggests,* to make the space intended for the cocoon more roomy by causing a bulge on the under side of the leaf from the contracting of these fibers.

Up to this point the life of the larva occupies from eighteen to twenty-five days, and it attains an average length of about 5.4^{mm} ($\frac{1}{5}$ inch).

The length of time elapsing between the completion of the cocoon and the change to pupa I have not definitely ascertained; but that it is very short is shown by the fact that two larvae left engaged in spinning at 4 o'clock in the afternoon had completed the transformation at nine the next morning.

The last larval skin is extremely delicate and elastic. Upon being shed within the cocoon it shrinks away so as to be almost imperceptible. Upon comparing it with the last skin shed *without* the cocoon it is seen to be only about one-tenth its size, or rather to occupy only about one-tenth its space. The utility of this is obvious when we think of the contracted space of the cocoon. The extreme delicacy of this last skin enables one to see plainly the formation of the chrysalis within with a moderate microscopic power and a strong transmitted light.

The chrysalis is light brown in color and about 4.2^{mm} (.16 inch) in length. The most remarkable point about it is the toothed crest upon its forehead, which enables it doubtless to pierce or saw through the cocoon. Fig. *n* shows a side view, and *o* a front view of this crust, showing the sharp teeth. The posterior end of the body is squarely cut off, and is furnished with three minute forward-curved, finger-like hooks, which undoubtedly serve to hold the chrysalis in position by hooking into the silk of the cocoon during the exit of the moth, but not to any extent before, as the chrysalis readily falls out when the cocoon is cut open. As the chrysalis advances in development the colors of the con-

* Psyche, vol. ii, page 150, "On Larvae of Tineina, especially of Lithocolletis," by V. T. Chambers.

tained moth begin to be plainly visible, and it seems to be completely differentiated a day or two before it makes its exit.

Eight days after the first pupae were found the moths began to make their appearance. Each pupa first sawed through the cocoon near its juncture with the leaf and worked its way through the gap, by means of the minute backward-directed spines upon its back, until it reached the upper cuticle of the leaf. Through this cuticle it sawed in the same way that it did through the cocoon. The hole was in each case just large enough to permit the chrysalis to work its way out, holding it firmly when partly emerged. When half way out it stopped, and presently the skin split across the back of the neck and down in front along the antennal sheaths, and allowed the moth to emerge.

The moth is a delicate little creature, with a body about 3^{mm} (.12 inch) long, and with a stretch of wing of about 7^{mm} (.28 inch). The front wings are white, with three broad irregular bronze bands across each one, each band being bordered with black on its inner side. The hind wings are silvery.

From the time when these insects were first observed until the end of the season the moths were constantly issuing, there being almost no regularity in the generations, so that from this season's observations it would not be easy to state definitely the number of broods. The cycle of the insect's life occupying, as it does, but a single month, more or less, in this latitude, with seasons varying in length and degree of warmth, the number of broods will vary by one or two. Five or six is probably a close approximation.

Upon the approach of cold weather, all the larvae which have entered upon the last larval stage, the round form, undergo no further transformations at that time, but remain in this stage through the winter. The larvae which have not yet reached this stage continue their development up to this point, unless frost and the fall of the leaves cut them off, and also hibernate as round larvae. This arrest of development, if it may be so termed, of the larva before its last molt, took place this year (and it is probably usually the same) with the advanced larvae several weeks before cold weather set in, at just that point when the development of another generation would have been impossible, thus securing the hibernation of almost every individual. An examination of the leaves in December revealed the fact that dead partially grown larvae were very rare indeed in the mines. All through the winter the dead leaves on and under the oaks most infested during the summer were full of the round larvae. Not a single pupa was found, though hundreds of mines were opened and examined. Such pupae as there may be upon the fall of the leaves (though they are probably very few, if indeed there are any at all, from the reasons just stated) either give forth the moths or are killed by the frost. The moths may possibly hibernate in small numbers, though we have no evidence of such hibernation.*

Early in March the hibernating larvae revived after a few days of warm weather and began spinning their cocoons. During the winter

* Mr. Chambers says (*ibid.*, p. 143): "Neither can I conceive any good reason why moths disclosed late in the fall might not winter, and indeed the moths of *L. robiniella* and *L. salicifoliella* do; but I have never met with any others hibernating, and indeed I have not seen *L. salicifoliella* later than November. There are, however, some facts about the hibernation of the species which need further explanation. Thus, I have known *L. tubiferella* Clem. and *L. aesculisella* Cham. to pass into their last larval state in the middle of August and to remain in that condition until late in the fall, when my last observations were made upon them, and in such cases there was abundant warmth and time for another brood before the fall of the leaves."

there had been no signs of silk in their mines. The spinning of the cocoons in every instance studied occupied about two days, and the larvae transformed in a very few hours thereafter to pupae, in which stage they presumably, under ordinary conditions, remained until the putting forth of green leaves. In the breeding room, however, kept at an average temperature of 68° F., the moths began to issue on March 20, 15 days after the transformation, nearly double the time in which the midsummer brood remained in this state.

REMEDY.

From a brief review of the natural history of the insect under consideration, it would seem that an efficient remedy would be readily found in raking up and burning the fallen leaves during winter, when they contain the hibernating round-form larvae. This would, indeed, in the majority of cases, prove all-sufficient. But, unfortunately, there are oaks the dead leaves of which cling persistently to the twigs throughout the whole winter; so that upon the department grounds, for example, although all leaves are carefully collected late every fall, there still remain enough on the trees to start a bounteous crop of leaf-miners the next season. The saving of leaves for manure is a doubtful economy when infested with leaf-miners like *L. hamadryadella*. If the collecting of the leaves be postponed until spring, the starting buds will have forced them off without exception, and the miners can be completely destroyed.

FITCH'S OAK-LEAF MINER.

(*Lithocolletis Fitchella* Clem.)

Order LEPIDOPTERA; family TINEIDAE.

Forming a tentiform mine on the under surfaces of the leaves of different oaks, a minute, nearly cylindrical, white larva.

Upon the under sides of the oak leaves during the past summer were found many mines of this insect, described years ago by Dr. Fitch.* Although belonging to the same genus as the insect which we have just described, and although resembling it considerably in the adult form, in its early stages and in the character of its mine *L. Fitchella* presents marked differences.

From the empty shells which we find abundantly upon the under side of the leaf the egg seems to be very similar to that of *L. hamadryadella*. Its greatest diameter is .116^{mm}, and in shape it is lentiform. From two to a dozen of these egg-shells will often be found on the under surface of a leaf upon which there is but a single mine, and when we take this fact in connection with the number of larvae that are parasitized we can see the small proportion which the insects arriving at maturity bear to the number of eggs originally laid by the female moth.

The newly hatched larvae do not vary sufficiently from those full grown to merit special remark. The mine, unlike that of *L. hamadryadella*, is plainly evident from both sides of the leaf. It belongs to that group of mines called *tentiform*, from the fact that the under cuticle

* Fifth N. Y. Rept., sec. 327, under the name of *Argyromiges quercifoliella*. Afterwards redescribed by Clemens (Proc. Acad. Nat. Sci. Phila., 1860, 217), Fitch's name being preoccupied. See Chambers's Index to N. A. Tineina, Bull. U. S. Geol. Survey, vol. iv, No. 5, p. 154.

being separated by the mining larva, shrinks as it dries, thus throwing the opposite side of the leaf into a projecting fold. The mine is thus more roomy, and we should expect to find in it a larva which is not so flat as that of the white blotch oak-leaf mine, and such is indeed the case. When the mine is made along the edge of a leaf, this contracting of the under skin causes the edge to turn over in such a way that, at a casual glance, it much resembles the work of a Tortricid or leaf-rolling larva. The color of the mine is a dirty yellow. While the larva is yet young it does no more than separate the under cuticle from the parenchyma, so that for some time the mine is not noticeable from the upper side, except from the elevation caused in the manner just described. When, however, the mine has become of sufficient size to afford it a comfortable working place, the now half-grown larva attacks the parenchyma, eating all but the upper epidermis and the stronger veins. This is done at first around the edges of the mine as laid out, but gradually the work advances inward to the center until all, or nearly all, is eaten, and the surface of the leaf *above* the mine presents a skeletonized appearance. Frequently, however, the larva attains full growth before this is completely accomplished, and from this fact mines are often found which, when seen from above, appear simply as a skeletonized circular band, inclosing a normal green center of greater or less size.

The full-grown larva is between 4^{mm} and 5^{mm} in length (from .15 to .19 inch). It does not belong to the so-called "flat" group of Lithocolletis larvae, but rather to the "cylindrical" group, and, consequently, does not present such abnormalities of structure as we have seen in the larva of *L. hamadryadella*. The mouth parts are normal, the thoracic legs are large and well developed, each being armed with a terminal claw, the prolegs are present in normal number and normal position, though rather small, and the whole appearance of the larva is such that at a glance it would be called lepidopterous. The general color is nearly white, the mouth parts being tipped with brown, and there is no appearance of the darker horny shields which gives the flat larvae so characteristic an appearance. The anterior (thoracic) segments of the body are larger than the others, and the head is retractile within the first. The abdominal joints are of nearly uniform size. Over the surface of the body are scattered a few long white hairs. The excrement of *L. Fitchella*, for some unexplained reason, seems to differ in character from that of *L. hamadryadella*. In the case of the latter, as we have already stated, the whole floor of the mine is spotted with the frass, which seems to have been smeared on when very moist, and, drying, has become hard and black. In old mines in which more than one larva has been at work the floor is covered with what looks like a thin sheet of cracked black enamel. With *L. Fitchella*, however, the excrement consists of minute, dry, hard pellets, which are collected together in some one part of the mine, leaving the floor perfectly clean. The cast-off skins of the larva are also to be found in this ball of pellets.

When the larva prepares for pupation it spins no regular cocoon, as does *L. hamadryadella*, but simply weaves a network of fibers back and forth from one side to the other of the mine. Then stationing itself in the midst of this mesh of silken fibers, supported on all sides without touching the walls of the mine, it casts its last larval skin; the quantity of silk thus spun varies greatly with different individuals, some spinning enough to form an irregular and delicate oval cocoon, others having almost no silk in their mines. The color of the silk varies from white to light brown.

The pupa is of a very light brownish-yellow color at first, but just

before giving out the moth it becomes darker on the head, back, and wing cases. In many important features it resembles the pupa of *L. hamadryadella*, but differs in others. It is longer and more slender, as was to be expected from the differing shapes of the larvae. The other differences are just such as the differences in habits would lead us to expect. The pupa of *L. hamadryadella* has to cut its way through a comparatively tough silken cocoon, as well as the upper epidermis of the leaf, and hence we find that its forehead is armed with a prominent beak furnished with a cutting and rasping edge, with marked serrations, with which it easily works its way out. With *Fitchella* there is no cocoon, but the lower epidermis of the leaf has to be cut; hence we find that the beak is still present, but in a more rudimentary form than in the former case, no serrations whatever being observable. The conditions in which the latter is found, however, require a development of organs which the former either does not possess or which are only rudimentarily present. These are appendages to hold it in position in the midst of the network of silken threads. The pupa of *L. hamadryadella* has upon its last segment four very minute, outward-curved hooks, which serve to hold it in position after it has worked its way half out of the mine, and while the moth is emerging. In *L. Fitchella* these hooks are greatly lengthened, and undoubtedly are of great use. In addition to these hooks, at the juncture of the penultimate and antepenultimate segments of the body there is upon each side a strong elevated ridge slightly directed backwards, which answers the same purpose, but the peculiar shape of which argues its development for some other purpose difficult to surmise. Just below the beak on the ventral side of the body are six delicate, downward-directed hooks, and from the whole back and sides of the body project a number of long, slender hairs, each having as its base a small but distinct tubercle. These all seem to be provisions for the same end.

The chrysalis at maturity takes almost precisely the same preliminary steps to giving out the moth as did that of the last insect studied. It works its way to the nearest wall of the mine, and, cutting through the thin leaf skin, wriggles out until half of its body is in the open air. In this position it is firmly held, the anal hooks being entangled in the loose silk within the mine, and the moth makes its exit through a longitudinal dorsal split in the thoracic skin.

The moth is very small, measuring only about 7^{mm} (.27 inch) in expanse of wings. Its general colors are white and bronze. These moths may be often seen walking leisurely about on the oak leaves through the summer, their wings folded close to their body, and their long delicate antennae in constant vibration. While in this position a white crescent-shaped mark appears across the back, giving them a characteristic and unmistakable look; when the wings are spread, however, this crescent resolves itself into two wedge-shaped marks, one on the lower border of each fore wing.

The time required for the development of the larva and the number of broods in a season approximate closely to the corresponding points in the history of *L. hamadryadella*. Dr. Fitch seems to have observed but one brood in New York, as he says:

> It is the latter part of summer when these blister spots begin to appear on the oak leaves. They occur on the topmost leaves of the tallest trees, as well as those that are lower and near the ground. After the leaves have fallen in autumn a portion of these blisters will be found empty, while others have pupae or sometimes larvae in them, showing that the moths come out from them in autumn, and also in the spring.

It seems to us that a safer conclusion would have been that the empty mines did not necessarily indicate that some of the moths issued in late

fall, but rather that they were the mines of an earlier brood. Hundreds of mines have been opened during the months of January and February, and the insect has never been found in any other than the pupa state, and no hibernating moths have been seen.

Inasmuch, then, as the insect hibernates in the pupa state within the mines in the dead leaves, the remedy is obviously the same as that proposed for the ravages of *L. hamadryadella*.

We here introduce detailed descriptions of the larva and pupa, as those of Dr. Fitch were very incomplete, and quote Clemens's description of the adult, so that it will be possible for our readers to recognize the insect in any of its stages.

LITHOCOLLETIS FITCHELLA Clem.

Larva.—Length, when full-grown, 4mm; width of first thoracic segment .81mm; subcylindrical, flattened somewhat dorso-ventrally; head triangular, retractile; 1st thoracic segment largest, others subequal, but tapering slightly to the end of the body. When young the thoracic segments are much larger than abdominal segments. Color creamy white, alimentary canal being dimly seen as a dark shade through the semi-transparent integument; tips of mandibles and thoracic tarsi brownish. Thoracic legs strong and well developed; 8 prop-legs, anal pair well developed, the first three pairs not well developed. No indication of a horny prothoracic or anal plate. Whole upper surface and sides of the body with sparse long white hairs.

Pupa.—Average length 4.6mm; average breadth at stoutest part of body 1.09mm. General color pale yellow, with brownish tinge to wing covers and dorsum of thorax; wing covers reaching to the penultimate abdominal segment; clypeus prolonged into a strong but short forward-curved beak with smooth edges; face with four short, slender, excurved tentacles; anal segment with four excurved hooks at tip. Eighth adbominal segment with two semi-circular, incurved, longitudinal, horny ridges, approaching each other ventrally, and visible dorsally only as lateral prolongations of the posterior border of the segment. From various parts of the abdomen issue long white hairs, each hair arising from a definite tubercle.

Imago.—"Head, face, and thorax silvery white. Labial palpi tipped with pale ochreous. Antennae pale saffron; basal joint silvery white. Fore wings pale reddish saffron, with a slight brassy hue. Along the costa are *five silvery-white costal streaks*, all black-margined internally except the first, which is very oblique and continued along the costa to the base of the wing. All the costal streaks are short except the first. On the inner margin are *two conspicuous silvery dorsal streaks*, dark-margined internally, *the first very large* and placed near the middle of the inner margin, the second opposite the third costal streak. At the tip is a small round black spot, placed above the middle of the wing; cilia silvery gray, tinted with saffron. Hind wings grayish fuscous; cilia paler."

RETINIA? COMSTOCKIANA Fernald.

Order LEPIDOPTERA; family TORTRICIDAE.

Boring into the twigs and small branches of the pitch-pine (*Pinus rigida*), causing an exudation of resin; yellow-brown larvae, about 10mm (.39 inch) long, transforming within the burrow and giving forth small brown and gray moths. (Plate V, fig. 1.)

An examination of the pitch-pines in the vicinity of Ithaca, N. Y., in the early part of the past summer, revealed the fact that they were infested to a considerable extent by a heretofore undescribed pest. Upon the smallest twigs and limbs and upon the terminal shoots of the trees were observed exuding at intervals masses of pitch, mixed with the excremental pellets of some larva. In most cases there were two distinct layers of the resin to be seen, the lower dry, hard, whitish, weather-beaten, having evidently been exposed during the winter, while the upper mass was fresh, softer, and of a hoary, bluish color on the surface, yellowish beneath, having the appearance of a comparatively recent exudation. These resinous lumps, when occurring upon twigs or limbs, were, in the great majority of cases, upon the upper side, and

were seldom found upon a larger limb than the one represented in the plate.

A longitudinal section through one of these lumps showed a channel of greater or less size leading directly to the heart of the twig, and extending along toward its base for a distance of from 25mm to 50mm (1 to 2 inches). In this burrow was found a rather stout, yellowish-brown larva, apparently nearly full grown, and measuring about 10mm (.39 inch) in length. In other burrows the short, stout, brown pupae were found. They were quite active, and retreated to the bottom of the mine when the resin was cut into. A ring of strong spines surrounded the posterior border of each segment, and enabled them to move about in the mine with considerable rapidity. From other lumps the empty pupa skin was protruding for half its length, the pupa having worked itself to that position before giving forth the moth.

Some of the burrows examined extended in both directions from the point of entrance. Occasionally also the twig at the point where the resin exuded was completely girdled, and in other cases eaten out to such an extent that a very slight force would suffice to break it off. The larvae were in some cases found with their heads at the mouth of the burrow, but in the majority of instances the opposite was the case.

The moth which issues from the burrows is quite small and soberly colored. In the figure it is represented natural size; the darker shades are dark rust-color, and the lighter light gray. It belongs to the family Tortricidae, the larvae of which are usually leaf-rollers.

From what we have been able to learn, we conclude that there are two broods of this insect in a year, and that the second brood hibernates in the larva state. May 25 burrows were found from which the moths had already issued. In the breeding cages at Washington the moths issued until June 20, when the last one made its exit. August 23, larvae were received which were nearly full grown, and were presumably of the second brood. In the following January nearly all the larvae found were only about half grown; none were more than two-thirds grown.

At the approach of winter the larvae prepare their burrows for hibernation by lining them with delicate layers of white silk, which often form tubes closed at the lower end. The larva remains through the winter with its head at the posterior end of the mine. Before the change to the chrysalis state, however, this position is reversed and the head is towards the opening.

Wherever a twig is pierced and bored by one of these larvae the leaves begin to turn yellowish and the twig often dies. In many cases, however, more than one of the larvae are to be found in a single twig, and this of course more certainly insures its death. It seems probable that the principal damage done is the disfiguring of the shape of the tree by the destruction of terminal shoots.*

The moths bred from the burrows were submitted to Professor Fernald, who decided that they represented a new specie, sprobably belonging to the genus *Retinia*. This species he described in the Canadian Entomologist, vol. xi, p. 157. We quote Professor Fernald's description

* The resin exuding from the burrows of the *Retinia* is sometimes inhabited by dipterous larvae which correspond quite perfectly with Osten Sacken's rather incomplete description of *Cecidomyia pini-inopis*, a species which he described from larvae found in resinous cocoons on the leaves of *Pinus inops* in the vicinity of Washington, and the adult of which he was unable to rear. The occurrence of these larvae in this exuding resin produced by *Retinia* would seem to argue that they are not normally injurious, and that the eggs are only laid in pitch exuding from some prior injury. We have not yet bred the adult of this insect.

of the moth, and append descriptions of the larva and pupa so that the insect may be recognized in whatever stage it is found.

RETINIA? COMSTOCKIANA Fernald.

Head in front, basal joints of antennae, and palpi white; last joint of palpi and a few scales upon the outside of the middle joint dark gray. Eyes black, vertex light sulphur-yellow to straw-yellow, antennae dark brown, annulated with whitish. Thorax above white, with a few scattered gray scales; beneath silvery white. Abdomen above light brown, with a silvery luster; lighter at the end of each segment; beneath lighter; last segment in the females darker brown above and beneath, and without the silvery luster. Anal tuft in the males light straw-color. Fore and middle legs light brown, femora and tibiae of hind legs white, tarsi of all the legs brown, ringed with white. Fore wings ferruginous brown, the extreme costal edge from base to near the apex dark brown. A number of small white spots rest upon the costa, four hairs beyond the middle, from all of which stripes composed of white and leaden hued scales extend more or less irregularly across the wing at nearly right angles with the costa, and having something of a wavy appearance in some specimens, with some indication of a basal patch, a central and subterminal band composed of the leaden and white scales. Fringes light brown above and beneath; fore wings light brown beneath, ferruginous apically, with the white spots of the costa well indicated. Hind wings above and beneath grayish brown, with a tinge of ferrugineus in some specimens, and with darker irrorations on the costa and outwardly; fringes long at the anal angle, somewhat lighter and with a darker line near the base.

Expanse.—Female, 18-20mm; male, 18-20mm.

Habitat.—Ithaca, N. Y.

Described from two males and three females.

I have provisionally referred this species to the genus *Retinia*, for although it agrees with the definition of the genus as given by Heinemann in other respects, the venation of the fore wing differs in the origin of veins four and five, which are not from the same point, but a little remote from each other; the distance between veins five and six at their origin is about twice the distance between veins four and five.

The moth has also been taken by Mr. Otto Lugger at Baltimore, Md.

Larva.—Length, when full-grown, 12mm, cylindrical, tapering very slightly at the ends. General color yellowish; head, thoracic plate, and piliferous spots brown and highly polished; anal plate dusky and somewhat polished, under a high power covered with shallow pits. The piliferous warts are large and quite prominent, each bearing a stiff hair. Their arrangement is normal. The anal shield is furnished with two transverse rows of four hairs each, the posterior row, from a dorsal view, appearing to fringe the end of the body. The stigmata are light colored, surrounded by a dark-brown chitinous ring. Thoracic legs and bases of prolegs brownish.

The young larvae differ in being darker colored. The head and thoracic shield are lighter; the piliferous spots are hardly discernible; the stigmata are much larger in proportion to the size of the larva, and their dark circumference is very strongly marked.

Pupa.—Length 7mm. General color dark shining brown, darkest on dorsum of thorax and head; wing-sheaths broad, extending to third abdominal segment. The posterior border of each abdominal segment dorsally elevated to a spiny ridge, bearing many strong backward-directed spines. Anal segment somewhat truncate, with a number of slender hooked filaments. Eyes very black and prominent. Between the eyes two pairs of the hooked filaments, having their origins close together and spreading.

Two species of Ichneumonid parasites have been bred from the larvae, both furnished with long ovipositors to pierce the resinous mass. They belong to the genera *Ephialtes* and *Agathis*. Mr. E. T. Cresson has favored me with the following description of the former.

EPHIALTES COMSTOCKII Cresson (n. sp.).

Female.—Black, shining; thorax smooth, very feebly punctured; metathorax smooth, rounded, with two abbreviated, longitudinal, feebly developed, elevated lines on disk, slightly divergent posteriorly; tegulae white; wings hyaline, subiridescent, nervures and stigma fuscous, the latter with a pale spot at base, areolet as usual; legs, including coxae, bright fulvous, posterior tibiae and tarsi black; abdomen about twice the length of the thorax, distinctly punctured, sides of the second and following segments tuberculated; first segment a little longer than broad, broadly excavated at base and slightly grooved on disk above; second segment longer than broad, widened posteriorly; third and fourth segments quadrate, remainder transverse; ovipositor as long as the body. Length of body .35 inch.

Hab.—Ithaca, N. Y. Parasitic upon *Retinia Comstockiana* Fernald.

THE FRUSTRATING RETINIA.

(*Retinia frustrana* Scudder MSS.)

Order LEPIDOPTERA; family TORTRICIDAE.

Infesting the new growth of *Pinus inops* and *P. rigida* (and perhaps of other species), spinning a delicate web around the terminal bud, and mining both the twig and the bases of the leaves; one or several small yellowish larvae, which transform within grayish cocoons, either in their burrows or fastened to the twigs, and become small copper-colored moths, with wing expanse of 12mm (.47 inch). (Plate V, fig. 2.)

About the middle of May, 1879, the scrub-pines (*Pinus inops*) in Virginia, near Washington, were found to be greatly injured by small lepidopterous larvae. On many trees there was scarcely a new shoot to be found which was not infested at its tip by from one to four yellowish black-headed caterpillars. They were so completely concealed while at work that their presence would scarcely be noticed, and the effect of their work was hardly visible until the twig was almost completely destroyed. Upon close examination a delicate web was seen inclosing the base of the bud and the surrounding new leaflets, resembling much the nest of a small spider. When this web was removed, one or several little yellow caterpillars were seen either retreating into a mine in the bud or into the bases of the leaves, which were also mined, or, not infrequently, they dropped from the twig, suspending themselves by a silken thread. The bud was often so hollowed that it dropped to pieces almost at a touch.

At the time when they were first noticed larvae of almost all sizes were to be found. Some were apparently almost full-grown, while others hadevidently not been long hatched. The nearly full-grown specimens measured 8mm (.31 inch) in length. The first pupae were obtained early in June. Most of the larvae transformed within the burrows which they had made, first spinning more or less of a silken envelope about themselves. Others, however, issued from their mines, and spun rather tough grayish cocoons between the leaves. The pupae were short, stout, and brown in color, with each segment furnished dorsally with two serrated lines, one consisting of large and the other of fine teeth.

The first moths issued June 13, the pupae having previously worked their way, by means of the spines just mentioned, into such positions that they could give forth the moths without injury to the latter, and a few weeks later almost every shoot had one or more of the empty pupa skins protruding from it. Specimens of the moths were sent to Professor Fernald, who determined them as identical with Mr. Scudder's manuscript species *Retinia frustrana*. In August Mr. Scudder gave a short account of this insect before the entomological section of the American Association for the Advancement of Science, at Saratoga. He had found it in such numbers upon the island of Nantucket in the young trees of *Pinus rigida*, planted there some years ago to repair the damage done by burning during the war of 1812, as to seriously threaten the success of the experiment. Mr. Scudder intends publishing an account of the workings of the insect in that locality very shortly.

In the latter part of July specimens of the twigs of *Pinus rigida* were received from Mr. S. H. Gage, of Ithaca, which had evidently been infested by the same insect, although no living inhabitants were to be found. In September other specimens were received from the same gentleman, and this time two pupae and one larva were found. According to Mr. Gage, the insect is not very common in that locality.

In the latter part of August, individuals of the second brood were very abundant in the scrub-pine in the vicinity of Washington. As before, they were found in almost every stage of growth, and the difference was even more marked. In one instance five larvae of greatly differing sizes were found in one shoot. The smaller ones were boring into the bases of the leaves, and the larger ones into the twig proper. The largest of the five had made quite a long channel from the tip of the bud down into the heart of the twig. Pupae were also found at this time, which did not give forth the moth until late in the winter.

The usual mode of hibernation is in the pupa state. A thorough search in January in the field showed only pupae. The pupae collected in August and September did not begin to give forth the moths in the breeding cages before early January, though this was continued at intervals through January, February, and March, and was greatly hastened without doubt by the heat of the room. On February 15, however, a few twigs were collected, from one of which, on February 28, a full-grown larva had emerged and was found crawling about the cage. This would seem to indicate occasional larval hibernation.

As to remedies, the only one which I can suggest at present is that involving the somewhat arduous task of picking off the infested twigs in early winter and burning them. Whether the salvation of the trees will be worth this labor in greatly infested regions will depend entirely upon their value to those interested.

As Mr. Scudder has prepared descriptions of all stages, we will not trespass upon his ground by appending further descriptions than we have already given. Our figure will assist in the recognition of the species.

THE PITCH-PINE RETINIA.

(*Retinia rigidana* Fernald [new species].)

Order LEPIDOPTERA; family TORTRICIDAE.

Inhabiting terminal shoots of *Pinus rigida*, and of similar habits to the Frustrating Retinia, a gray, brown, or blackish larva 8mm ($\frac{1}{3}$ inch) in length, which in its perfect form becomes a small moth with dingy white wings, marked with dark red and silvery gray.

In the summer and fall of 1879, Mr. S. H. Gage, of Ithaca, N. Y., sent to the department specimens of the pitch-pine containing Tortricid larvae and pupae, which in their work resemble *Retinia frustrana*, but differ from that insect in coloration and in being slightly larger. These developed into a moth intermediate in characters between *R. frustrana* and *R. Comstockiana*, and which has been described by Prof. C. H. Fernald as follows:

RETINIA RIGIDANA Fernald (n. sp.).

Head sordid white, with a yellowish tinge: front and palpi inclining more to ashy; antennae brown, annulated with white; thorax above very light gray, washed with dull ochreous, deepening to a coppery tint on the front of the patagiae.

Thorax beneath, abdomen and hind wings above and beneath, and fore wings beneath light gray, with a silky luster: fringes of the hind wings lighter, with a line near the base concolorous with the wings.

Fore wings above sordid white, with a basal patch occupying the basal fourth of the wing, composed of about four irregular cross-streaks of dark red, alternating with similar streaks of silvery gray, the outer red streak sending out a tooth on the fold. The light space following the basal patch has several small gray costal spots, from which light ochreous streaks extend across the wing. A dark-red band extends across the wing beyond the middle, divided on the costa by a geminate white spot. Below

the cell the basal half of the red band is replaced by stripes of light ocher-yellow and silver-white; the remaining portion of the red band below the cell is curved outwardly, making this part convex on the outside and concave on the side towards the base.

The apical portion of the wing is dark red, changing to bright ocher-yellow inwardly, and towards the anal angle divided by a subterminal geminate broken line of silvery scales, extending from the costa to the anal angle.

Fringe reddish-purple. The costa from the basal patch to the terminal band is marked with geminate white spots, alternating with gray.

Posterior femora and tibiae very light silky grey; fore and middle femora and tibiae gray, with coppery reflections, the tibiae banded with white. All the tarsi gray, with whitish tips.

Expanse.—Female, 18^{mm}.

Habitat.—Ithaca, N. Y.

Described from two females, one in the collection of the Department of Agriculture, the other in my collection.

C. H. FERNALD.

One Ichneumonid parasite belonging to the genus *Cremastus* has been bred by us from this species. It was referred to Mr. E. T. Cresson, who characterizes it as follows:

CREMASTUS RETINIAE Cresson (n. sp.).

Male.—Head brown; face, orbits, clypeus, mandibles, and palpi yellow; middle of face clouded with fulvous; antennae long and slender, black, scape beneath dull fulvous; thorax dull yellowish-brown; lobes of mesothorax darker medially; prothorax yellow; scutellum dull yellowish; metathorax black, the flanks shading into brown, the elevated lines well developed; tegulae yellow; wings hyaline, iridescent; stigma large, and with the nervures fuscous; legs yellowish, varied with brown, especially the posterior pair, the tips of whose tibiae are blackish; abdomen, with the two basal segments, black above, yellow beneath, the remaining segments reddish, with a black spot at base above. Length .25 inch.

Hab.—Ithaca, N. Y. Parasitic upon *Retinia rigidana* Fernald, a Tortricid.

THE PINE LEAF MINER.

(*Gelechia pinifoliella* Chambers [new species].)

Order LEPIDOPTERA; family TINEIDAE.

Mining the leaves of different species of pine, a minute, brown, narrow, cylindrical larva. (Plate V, fig. 6.)

For several years the leaves of the common pitch pine (*Pinus-rigida*) in the vicinity of Ithaca, N. Y., have been seen to be extensively mined by the larvae of a Tineid, the life history of which we have first studied the present season. The end of the leaf, and in many cases the entire leaf above its base, becomes dead and brown, and when opened it is found to be entirely eaten out, and to contain, in the proper season, the larva or pupa of the above-mentioned insect.

What are in all probability the eggs of this insect have been found deposited singly near the base of the leaves. They are nearly round, flattened on the side of attachment, and slightly so on the opposite side. Their average diameter is $.14^{mm}$ (.05 inch). The general color is reddish brown, differing in intensity with the stage of development. The surface of each egg is marked with numerous delicate carinae, which meet at the center, somewhat resembling those of the cotton and boll worms figured in the article on cotton insects. We have not proof positive that these are the eggs of this leaf miner, but their size, appearance, and place of deposit seems to indicate that they are.

The work of the growing larvae is well shown in the plate, and also the larva itself, highly magnified. From a study of the mines the larva appears to burrow towards the end of the leaf first. Should it arrive at the end of the leaf (and it almost invariably does) before attaining

full growth, it reverses its position and mines towards the base. The hole of entrance and of future exit is apparently in all cases enlarged and the excrement pushed through, as there is but little frass to be discovered in the mine, while it can always be found in a greater or less quantity at the opening or on the leaves below. No instance has been observed in which one larva has injured more than a single leaf of *P. rigida*, but a specimen of this insect was found in Virginia upon the common scrub-pine (*P. inops*), the leaves of which are shorter and more slender than those of the pitch-pine, and, from observations made upon it, it would seem that one leaf, if small, does not afford all of the food needed by a larva.

When found on the 1st of January this specimen was hibernating, the mouth of its burrow being covered with a thin silken curtain. Six days after, being transferred to a warm room, it was found that this curtain had been broken and the insect had left its mine. It was soon found on another leaf, and the same day formed a new burrow, where it continued to eat until January 23, at which time it had completely excavated the leaf. After this date all operations appear to have been suspended, and there were no signs of life in the burrow until March 3, when a Proctotrupid parasite issued.

Leaves of *P. rigida* are frequently observed to be completely mined out, and nearly full-grown larvae are occasionally found crawling about over the leaves and twigs; so it seems probable that with this species of pine also two leaves may sometimes be successively mined by the same larva.

The full-grown larva is nearly 5^{mm} in length (.19 inch). Its color is light-brown, with the head and prothoracic shield and the anal plate black. The body is clothed with a few delicate hairs. The form of the larva is shown in the plate. Upon reaching full growth the larva spins a slight covering to the mouth of the mine and retreats a short distance above it (from 10^{mm} to 15^{mm}). There, after spinning a few supporting lines of silk, it transforms to a long and slender chrysalis, light-brown at first but afterwards nearly black. When removed from the mine the pupa is very active, jerking the short end of the abdomen (which extends below the wing cases) from side to side with rapidity. The duration of the pupa state is from ten to fourteen days. The moth makes its exit from the pupa shell without disturbing the position of the latter, leaving it attached by its threads some distance up the mine, and works its own way to the entrance.

There are certainly two broods of this insect each year, probably three, and possibly more in exceptional seasons. Of the general hibernating habits of the genus Stainton says: "Of a few species the young larvae live through the winter, but I believe the greater number pass the winter in the egg and pupa state." With the present species the nearly full-grown larvae have been found during the winter, but not in great numbers. What we consider to be the eggs of this species have also been found in apparently healthy condition in midwinter, and the insect, without much doubt, hibernates in both of these forms, and possibly in either of the others. The moths of the first brood issue during the entire month of June, the difference between the earlier and later ones probably depending upon the form in which they hibernate.

As we have stated before, larvae almost identical in appearance with those found on *Pinus rigida* in New York have been discovered on the scrub-pines (*P. inops*) around Washington. These larvae were bred to the perfect state and proved to be the same species.

A leaf miner of precisely the same habits and of almost the same ap-

pearance was found the past winter in the leaves of the southern pine (*P. australis*) at Macon, Ga., a point where, owing to a sudden fall of some 400 feet in altitude, the northern and southern floras meet in a remarkable manner. Progressing southward, a careful search was made for additional specimens of this leaf miner, but none were found except in this one locality. Assuming the identity of the two forms (they have since been bred and proved identical), it puzzled us for some time to discover how the species could have reached *P. australis*, since the southernmost limit of *P. inops* is South Carolina, and *P. rigida* is essentially northern. It was not until we discovered the same miner in leaves of the yellow pine (*P. mitis*) that we were able to solve the problem. The yellow pine is not only found north, but also extends south until at Macon, Ga., we can see it mingling with the northernmost specimens of *P. australis*.

The following characterization of the species has been written for this report by Mr. V. T. Chambers:

GELECHIA PINIFOLIELLA Chambers (n. sp.).

Palpi simple: hind wings excised beneath the tip. Head white, flecked with scales of the general hue of the insect, which may be called a brownish yellow, though it is difficult to define its color in a word. Palpi white; the second joint longer than the third, brownish yellow flecked with fuscous scales on the outer side; third joint white with a brownish yellow annulus about its middle, and another near the tip: antennae white, each joint crossed by a brownish band. Thorax and fore wings of the general hue above mentioned, flecked with fuscous scales. On the fore wings are three white fasciae, placed respectively at about the basal, middle, and apical fourths of the wing length; the apex is densely dusted with fuscous on a white ground, and the dorsal margin is sparsely flecked with brown. The fasciae also are more or less margined with brown scales and the third one is sometimes interrupted in the middle; and the fuscous scales which margin the first and second fasciae (especially along the second, near the fold) form minute tufts of raised scales. Cilia grayish, with interspersed black scales, which are tipped with white. Underside of the fore wings brownish. Hind wings pale grayish with white cilia; abdomen brown above, whitish toward the apex beneath. *Al. exp.* ⅜ inch.

Received from Professor Comstock, who informs me that the larva mines the leaves of a species of pine.

Since the above description of *G. pinifoliella* was prepared, I have received a letter from Mr. Stainton, in which he says that it "is unknown to me, though I imagine from your account it must bear a superficial resemblance to *Oecophora augustella* and *Oe. luctuorella*." I cannot refer *pinifoliella* to *Oecophora*, however.—V. T. C.

To this description of the adult by Mr. Chambers, we here append a description of the immature forms:

Egg.—Seen from above appears globular with a diameter of .14^{mm}; seen from the side, appears so compressed that its long diameter is nearly twice the length of the short. Color reddish brown. Surface marked with delicate, close, meridional carinae, meeting at the center above and below.

Larva.—Length when full grown, 4.2^{mm}; average width, .58^{mm}. Subcylindrical; all segments except head and anal segment nearly equal in diameter, the exceptions smaller. Color yellowish brown; head, prothoracic, and anal plates dark brown; mouth parts yellowish; prothoracic shield strong, completely divided longitudinally in the middle by a moderately wide suture.

Pupa.—Length, 4.4^{mm}; average width, .71^{mm}. Head obtusely rounded; wing sheaths extending to 6th abdominal segment; antennal sheaths reaching nearly to end of wing sheaths, all compactly soldered. General form very nearly cylindrical; sixth and seventh abdominal segments spreading at posterior borders; dorsal side of anal segment furnished with a cluster of from 10 to 15 delicate tentacular or hook-form filaments. Color: When first transformed, light yellow-brown, soon changing to very dark brown, almost black, on head, thorax, wing, and crural sheaths; abdomen of a lighter brown, growing still lighter towards the anus.

PARASITES.

A minute chalcid of peculiar habits was bred in considerable numbers from the specimens found on *P. rigida*. From 8 to 12 of the larvae of

this parasite are usually found within the body of one of the leaf-mining larvae. The parasitic larvae are pale milk-white in color, with the alimentary canal blackish; they are long and slender in form.

A very small tachina fly was also bred, both from the northern and southern specimens.

ON PREDACEOUS LEPIDOPTEROUS INSECTS.

As nearly all of the insects which belong to the order Lepidoptera, which includes butterflies and moths, are in the caterpillar state purely vegetable feeders, the life history of any species which vary from this rule is of considerable scientific interest; and when, as is the case with those about to be described, these insects destroy other insects which are noxious, they become of interest to the practical man as well as to the scientist.

The insect popularly known as the cottony maple scale (*Pulvinaria innumerabilis*, Rathvon) has become a serious pest in many localities. In its adult state it is an oval brownish scale about one-fourth of an inch in length. From beneath its body projects a mass of white cottony excretion, which covers the eggs and young lice and also renders the insect very conspicuous. It is found in large numbers on maple, box-elder, and sycamore trees, and lately it has become common on grape-vines.

This insect is not an easy one to contend against, and hence any natural check to its increase is of high interest. During the past year I discovered a Lepidopterous enemy of this pest, which I described in a paper reap before the Saratoga meeting of the American Association for the Advancement of Science.* I will quote part of this paper:

THE COCCID-EATING DAKRUMA.

(*Dakruma coccidivora*, Comstock.)

Order LEPIDOPTERA; family PYRALIDAE.

While studying a colony of the cottony maple scale (*Pulvinaria innumerabilis*, Rathvon) which was found on a branch of *Negundo aceroides* in Washington, I was surprised to find a Pyralid larva living within the cottony mass excreted by one of these insects. On further examination it was found that very many of the bark-lice afforded retreats for similar larvae. This, with the fact that the eggs deposited by such individuals, or the young lice developed from them, had been destroyed, indicated that the Pyralid larvae were predaceous. One of these larvae was placed in a glass tube with a bark-louse, the eggs of which had not been destroyed. These eggs had just hatched and the cottony excretion was swarming with the young lice. The larva soon made its way under this mass, and after spinning a delicate silken tube about its body, began to devour the young lice greedily. The larva was placed in the tube at 5 p. m.; at 9 a. m. the following day it was found that fully one-third of the lice had been destroyed, showing that if these larvae occur in great numbers they would prove an efficient check to the spread of this pest of our shade-trees. It is an interesting fact bearing upon this point that as yet this bark-louse has not become common in Washington. Careful search revealed only a few sporadic individuals except upon a single box-elder tree; and there the predaceous caterpillars were so numerous that it was with difficulty that any scales were found not infested by them.

Although the caterpillar is well protected, living as it does within the mass of cottony excretion, it spins about its body a delicate silken tube. This tube reminds one of that spun by Galleria, but it is more delicate; and when seen within the cottony mass, it is with difficulty distinguished from it. When a branch is thickly infested by *Pulvinaria* these tubes extend from one bark-louse to another. The caterpillars are very active, moving freely about within these silken passages from beneath one scale to another.

At the time my observations were made (June 24), many of the caterpillars were full

* This paper was published in the North American Entomologist, vol. 1, pp. 25–29.

grown, and some of them transformed at once. The cocoon is made within the silken tunnel and is quite delicate, the pupa being plainly visible within it. Individuals of this brood remained ten days in the pupa state. The greater number of the moths bred by me this year issued July 17. Some, however, did not appear until August 13.

These moths are not easily disturbed, but will suffer the twig upon which they are to be handled freely without moving; and often they will not take to flight even when touched. They usually rest upon the two posterior pairs of legs and the tip of the folded wings, with the front pair of legs drawn closely to the body, and the whole body forming an angle of about 45° with the object upon which they are at rest. In this position they will remain motionless for hours.

Can it be that the slowness with which the coccid can spread has influenced the habits of this species in the adult state?

Several of the moths which issued July 17 were placed in a breeding-cage containing a twig infested with *Pulvinaria*. July 12 several eggs were found. These eggs were deposited singly either on the bark, the coccid scales, or the cottony masses. In the latter case they could scarcely be detected by the naked eye on account of their resemblance in color to the excretion. Six days after oviposition the eggs hatched.

I was unable to trace the history of the second brood for want of eggs or young bark-lice with which to feed the larvae. It is probable, however, that the habits of this brood are similar to those of the first. I am strengthened in this belief from the fact that I found newly-hatched *Pulvinaria* the day before the second brood of the *Pyralid* emerged from the egg.

The anomalous habits of this species are different from anything I have been able to find published. I do not think that it is to be classed with the few doubtful Lepidopterous parasites that have been recorded, or with the many inquilines known to science.

Of the former, the following are the most striking examples: First, the two moths described by Westwood in the Trans. Ent. Soc. London for 1876 and 1877, which were parasitic, in the sense of residing upon, the one on *Fulgora candelaria*, the other upon a species of *Aphaena*, also a member of this family *Fulgoridae*. Westwood is of the opinion that in each case the Lepidopterous larva feeds upon the waxy excretion of its host without in any way injuring it; second, the two Tineids, mentioned by Mr. Westwood (l. c., 1877, p. 435) as being parasitic upon the three-toed sloth. Speaking of these moths he says: "From the information I received with the last-mentioned specimens, I believe it was among the hairs of the *Bradypus* that the moths had either been reared or had taken up their abode."

The remaining instance described by Westwood, that of a single *Bombycid* moth bred from the puparium of a *Tachina*, as well as that described by J. W. Lea in the Trans. Ent. Soc. London, 1858, of a moth bred from pupa of *Lasiocampa trifolii*, are each too doubtful to serve as a basis for any conclusion.

In case of inquilines, of which many have been described (see especially papers by Walsh on Insects inhabiting Willow Galls, Proc. Ent. Soc. Phila., vol. vi, p. 270, also his report as State entomologist of Illinois, p. 79), it is supposed that they are vegetable feeders, and only occasionally or incidentally destroy the life of their unfortunate hosts.

Neither is this case to be classed with those instances of Lepidopterous insects feeding upon dead animal matter, as hair, wool, bone, horn, or entomological specimens.

Had a single specimen of this insect been observed to be carnivorous, I should have been inclined to consider this habit an accidental occurrence due to the larva finding itself under unnatural conditions. Every entomologist knows how frequently Lepidopterous larvae devour each other when imprisoned. In my attempts to rear *Heliothis armiger* this season I have been unable to breed more than a single specimen in a jar.

I have bred over forty specimens of *Dakruma coccidivora* from *Pulvinaria innumerabilis*. There was no indication of its feeding upon the tree on which it was found. Nor was there any evidence whatever that it feeds upon the excretory masses in which it lives.

Moreover those masses contained, in addition to remnants of destroyed lice and eggs, the excrement of the larvae in large quantities, showing that they had resided there for some time.

These facts I think warrant me in considering the species predaceous.

Since writing the above I have bred this insect from three additional species of Coccids, all from Florida. April 17, I received from W. H. Ashmead, of Jacksonville, Fla., many specimens of a large species of *Lecanium*, which is common on magnolia and bay. These bark-lice were found to be infested with larvae of *D. coccidivora*, which at that date were full grown. The adult moths from these larvae began to issue June 7.

I am also indebted to Dr. R. S. Turner of Fort George, Fla., for specimens of a Coccid allied to *Dactylopius*, from which I have bred *D. coc-*

cidivora, and for specimens of the common "soft scale" of the orange (*Lecanium hesperidum*), from which I have bred the same insect. And June 23, 1880, I received orange twigs which were badly infested by the latter bark-louse: and attached to the bark-lice were the characteristic eggs of this moth. These observations indicate that this species is widely distributed, and confirms my conclusion that it is normally predaceous.

DESCRIPTIVE.

DAKRUMA COCCIDIVORA.

Expanse, 10–18mm; length of body, 4–8mm.

♂ ♀.—Head above dark ash-gray with a faint coppery reflection, below and behind the eyes white. Eyes black and quite coarsely faceted. Lower surface of antennae pale brown; upper surface dark gray with coppery and green reflection. Labial palpi black sprinkled with white scales, and with the base almost entirely white. Maxillae rust red with the basal half clothed with white scales interspersed with a few black ones. Thorax above and patagia dark gray with brown and green reflection. Abdomen annulated with brown and light gray; the brown predominating above, the light gray beneath. Fore wings light gray marked with brown and black. A light band extends across the outer part of the basal third of the wing; the costal half of this band is wide, reaching nearly to the base of the wings; the remaining half is narrow. Near the base of the wings there is a short transverse gray band which is sometimes obsolete; exterior to this is a short longitudinal black spot, which also varies greatly in size and intensity of color. The light band which extends across the outer part of the basal third of the wing is bordered externally by a dark band, which is narrow on the costal, and near the middle of the wing widens so as to reach the outer third of the wing. There are two black discal spots which are sometimes distinct, but more often united so as to form a single crescent-shaped spot opening outward. The markings of the outer third of the wing resemble greatly those of *Acrobasis nebulo*, there being a row of six or seven dark spots on the outer margin, and one-fourth of the distance to the body a wavy light gray band parallel to the exterior margin, and bordered on each side with dark brown; the costal end of the outer of these brown borders is usually darker and widened externally, forming a conspicuous black triangular spot. Lower surface of the front wings dark gray especially toward the apex, with a faint brassy tinge. Hind wings light gray with the apex clouded.

Thirty-four specimens examined, 18 ♂, 16 ♀.

Chrysalis.—Length 6.5 mm. Color, dorsum dark brown inclining to blackish toward anus, venter a little lighter, wing and antennal sheaths yellowish brown. Wing sheaths reaching nearly to the 6th abdominal segment; antennal sheaths reaching to the tip of the wing sheaths; dorsum densely punctured, venter less so; stigmata at the tips of slight protuberances; tip of abdomen nearly surrounded by a whorl (complete dorsally, incomplete ventrally) of small pointed tubercles.

Larva.—Length of full-grown larva 8–12mm. Body cylindrical, tapering slightly toward each end. Head small, rounded, slightly bilobed, black and somewhat polished; antennae white, 4-jointed, basal joint largest, second about one fourth the length of the first, third nearly as long as the first but only about one-third as thick, fourth a mere tubercle. Upper surface of the body a greenish black color with a faint tinge of bronze; prothoracic shield black, finely granulated, and with a pale dorsal line; anal shield a little darker than the body and sparsely beset with long hairs. Stigmata and all piliferous spots brown with pale centers. Under surface of the body bluish green. Legs black with the nodes bluish green; the ring of hooklets of prolegs pale brown with light center.

Egg.—White, faintly glossy; oval in outline; ½mm long, ⅓mm wide; surface closely indented with large irregular five or six sided pits; the walls of the indentations forming sharp ridges over the surface of the egg.

Newly-hatched larva.—Length 5mm. Color, dull white tinged with yellow; head and thoracic shield dark brown; mouth-parts dull yellow; body attenuated; head and thoracic plate large, round, flattened dorso-ventrally; head with several long lateral hairs; each abdominal segment furnished laterally with a long stiff hair; thoracic and prolegs strong and well developed.

THE PALE DAKRUMA.

(*Dakruma pallida* [new species].)

Closely allied to the species just described is another insect with similar habits; for which, it being lighter colored in both larval and adult

states than *D. coccidivora*, I propose the name *D. pallida*, or the pale Dakruma.

I first found the larva of this insect living within a spherical gall-like bark-louse (*Kermes*), on oak near Sanford, Fla. Other specimens were received later, which were feeding upon the eggs of another species of bark-louse (also a *Kermes*), collected by Dr. R. S. Turner at Fort George, Fla.

The larva of this species is readily distinguished from that of *D. coccidivora*. It is of a light-gray color above, and white beneath; the head is brown, sometimes varying to reddish. When full grown the larva leaves the Coccid which it infested and makes a cocoon, which is attached to the outside of the coccid or to a neighboring twig.

The adult insect resembles to a great extent in its markings *D. coccidivora*; but is easily recognized by its lighter color, and by the absence of rust red scales. The discal spots are distinct in all of my specimens.

DESCRIPTIVE.

DAKRUMA PALLIDA n. sp.

Male, female.—Expanse, 18mm; length of body, 8mm. Head dark gray; eyes black and quite coarsely facetted; antennae pale brown; labial palpi light gray; thorax and abdomen above dark gray. Fore wings light ash-gray with black markings, and with the portion along the inner margin clouded; near the base of the wing there is a black spot; the wing is crossed at one-third of its length from the base by a dark band, the posterior part of which is obsolete, and the anterior part terminates in a narrow oblique line, directed inwards; two distinct discal spots; near the apex of the wing are two transverse, wavy, black bands; and on the outer margin six or seven black spots. Hind wings dark gray, with apex and posterior margin still darker. Lower surface of both wings dark gray. The lower surface of body silvery gray. Described from six specimens, two males and four females.

THE OAK COCCID BLASTOBASIS.

(*Blastobasis coccivorella* Chambers [new species].)

Order LEPIDOPTERA; family TINEIDAE.

At Cedar Keys, Fla., I found many specimens of a large Coccid* upon oak, some of which were pierced with a round hole and were entirely eaten out, having evidently maintained some parasitic insect. Upon cutting into other apparently sound specimens a few of the parasitic larvae were discovered, which were evidently lepidopterous. Those which appeared full grown were 8mm (.31 inch) in length, and were very plump in figure, the 4th and 5th abdominal segments being widest. The general color was milk white, the head being light brown and the mouth parts dark brown. The prothoracic plate was narrow, divided longitudinally in the middle, and was also light brown in color. They possessed sixteen feet—six thoracic and ten abdominal—all quite well developed.

A number of specimens were sent to Washington, where, on March 15, the larvae commenced to pupate. A round hole was first cut through the exterior of the Coccid, which, up to this time, had been intact, and a comparatively compact cocoon was spun outside, attached, however, to the edges of the circular hole. On April 1 the first moth was found, and on April 10 another emerged. From these two specimens Mr. Chambers has described the new species *Blastobasis coccivorella*. His description is appended:

*An undescribed species of *Kermes*, closely allied to *K. pallidus*, Réaumur.

B. COCCIVORELLA Chambers (n. sp.).

As mentioned in the description of *B. citriella*, this species, of which I have seen two damaged females, has the tuft projecting from the broad joint of the antenna; the face, however, is less elongate and narrow and is more convex than in the above-mentioned species, and it is also smaller and not so slender, and the submedian vein of the fore wings is not branched. It is sordid whitish, with a silky luster, dusted with fuscus, a fuscus streak on the fore wings on the base of the fold, one near the base within the costal margin, one on the disc, and the apical part of the wing is densely dusted with fuscus; hind wings stramineous. Professor Comstock informs me that the larva feeds on a large *Coccus* of the oak.

EUCLEMENSIA BASSETTELLA (Clemens).

Order LEPIDOPTERA; family TINEIDAE.

From the large gall-like bark-lice found on oak at Cedar Keys, Fla., we have also bred a beautiful greenish black moth, which has its fore wings marked with reddish orange. This species was first described by Clemens,* under the name of *Hamadryas Bassettella*, from specimens received from Mr. Bassett in Connecticut. The latter gentleman stated that he had bred it from a gall on oak, but subsequently Mr. Riley pointed out to him that his supposed gall was in reality a Coccid. The rearing of the same moth from what is evidently, if not the same, a closely allied species of Coccid from two such widely separated localities as Connecticut and Florida is a strong indication of the permanence of the carnivorous habit in this species.

NOTES OF THE YEAR.

[Under this head we record the more important of the isolated facts which have been brought to our notice during the year, and other material of a fragmentary nature which is of sufficient value to be published at once.]

THE COLORADO POTATO-BEETLE (*Doryphora decemlineata*, Say).—Specimens of this insect were received from Mr. David G. Lowe, Saint Agatha's Post Office, Manitoba. This is the farthest point north from which this beetle has been reported. Other specimens were received from Lynchburg, Va.; but in no instance has the species been reported from a point south of the territory indicated by the map in Professor Riley's ninth Missouri report as that invaded by the insect when it first spread eastward to the Atlantic Ocean. This indicates that there can be but little danger of the species spreading farther southward than the northern half of Arkansas, Tennessee, and North Carolina.

Encouraging news respecting the increase of the natural enemies of this pest has reached us from several sections during the past year. D. Landreth & Sons wrote from Bloomsdale, N. J., June 4, as follows: "We send you a small package containing four or five potato-bugs infested with an insect enemy new to us. Hundreds of bugs can be found upon our farm completely enveloped with swarms of lice. The lice eat up the potato-bugs, leaving only the shells." The parasite proved to be a mite, the *Uropoda americana* of Riley. Professor Riley received the mite from Painesville, Ohio, and Poughkeepsie, N. Y., and I have found it common at Ithaca, N. Y. It will probably follow the beetle to all parts of the country infested by it. The ground beetle, known as *Lebia grandis*, Hentz, was reported as being common in New York, and active in destroying the potato-beetle. It is represented at Plate V, fig. 3, both enlarged and of natural size.

* Proc. Ent. Soc. Phil., vol. ii, p. 423.

WESTERN DIABROTICAS (*Diabrotica soror*, Le C., and *D. trivittata*, Mann).—These western representatives of the well-known 12-spotted Diabrotica (*D. 12-punctata*) and of the striped squash-bug (*D. vittata*) of the east have been sent to the department during the past season by Mr. J. M. Dudley, of Dixon, Cal. The western species so resemble those of the east that from above they cannot be distinguished. Viewed from below, however, the abdomen of *soror* is black, while that of 12-*punctata* is greenish-yellow; and the legs of *trivittata* are nearly all black, while those of *vittata* are only slightly tipped with black at the joints.

The interesting point of Mr. Dudley's communication was that the specimens sent were doing considerable injury to apricots, eating into the ripe and nearly-ripe fruit. From a short correspondence which appeared in the columns of the Pacific Rural Press last fall, it would appear that the injuries to fruit of various kinds from these insects have become quite general, and the opinion is expressed that this has arisen from the lately-introduced custom, in parts of the State, of growing certain vegetables as orchard crops; the Diabroticas migrating to the neighboring fruit after the vegetables have been destroyed. At all events, the taste for fruit seems to have been recently acquired, but now that it has been acquired, it seems doubtful whether the abolishing of the orchard-crop system or the planting of a distasteful food would better matters to any appreciable extent. Indeed, it would be difficult to find a garden crop which the Diabroticas would not devour, as they are very general feeders. The editor of the Press says:

> So far as our observation goes, the insect will thrive and multiply wonderfully on quite a varied diet. In our garden the insect has a sharp appetite for rose-buds and opening pinks, for canna and dahlia leaves, for balsam leaves and flowers, and many other green and colored growths.

The question of protecting the fruit trees from these insects bids fair to become of considerable importance and also of considerable difficulty. War should be made upon them wherever observed. The experiments of Professor Hilgard with pyrethrum have proved that the powder has little effect upon these insects unless immersed in it; that the infusion applied in drops failed to enter the spiracles, but that the spray was very effectual. This will undoubtedly prove of use in the immediate future, now that the prospects for cheap pyrethrum are so good.

A DESTRUCTIVE ENEMY TO SUGAR-CANE (*Ligyrus rugiceps*, Le Conte).—Accounts have recently been received from different parts of Saint Mary's Parish, Louisiana, of the destruction of cane by a rather large black beetle, which proves on examination to be the *Ligyrus rugiceps*, described by Le Conte, from Georgia, in 1856. According to several correspondents, the beetle has been known to injure cane more or less in different parts of the parish for twenty-five years, but it is only within the last three or four years that its ravages have excited much alarm; although, in 1855 or 1856, the crop upon 80 acres of one plantation was completely destroyed by this or a similar beetle. During the present year it has become destructive on many sugar estates in the parish named; and, while in former years its work seems to have been confined to the "rattoon" cane, this year many acres of both "rattoon" and "plant" have been entirely ruined on some plantations.

From specimens which we have received, it appears that the adult insects bore into the stalk just above the root, and numbers of them may be found imbedded to different depths. It is said that one gentleman found 45 specimens in one "15-inch section of a row." Mr. Daniel Thompson, of Bayou Teche, reports that in some localities the same insect injures corn. This year the greatest injury was done very early in

the spring, while late in April and early in May numbers of the beetles could be seen upon the roads and about the houses, being especially active at night.

Correspondents were requested to search for the earlier stages of the insect about the roots of the cane, and it was not long before Messrs. Daniel Thompson, G. W. Thomas, and F. Dumartrait sent us pupae which they had found low down among the roots of the plant, upon which the larvae may have fed; the pupae proved, however, to belong to another beetle (*Phyllophaga glabripennis*, Le C.). Round white eggs were also found in the soil about the cane, but that they were the eggs of *Ligyrus* is uncertain. Mr. W. J. Thompson, of Bayou Teche, has also forwarded some immature lamellicorn larvae found in similar positions, but it will be necessary to rear them to the perfect state before we can pronounce upon them.*

From our limited study of the habits of this insect we do not feel warranted as yet in suggesting any remedial measures, our object in publishing the present notice being merely to call attention to the insect; though from the statement of Mr. E. D. Martin, of Baldwin Station, Saint Mary's Parish, that the beetles are readily attracted by lights, it appears as if lantern-traps might be used advantageously. These traps are treated of at some length in the article on the cotton-worm. I am also informed by Mr. J. Y. Gilmore that lime around the roots of the canes is proving successful in keeping away the beetles.

THE DISTENDED MAY BEETLE (*Lachnosterna farcta*, Le Conte).—Mr. David Donaldson, of Locke Hill, Bexar County, Texas, early in February last, reported great injury to his beans by a brown beetle, which upon receipt of specimens proved to be the above-named species. It seems that many of the garden crops are injured by this insect, but more especially beans. Two years ago his first planting was entirely destroyed by them. During the day they remained hidden underground or under stones and other rubbish, coming out at night and feeding upon the leaves and stems. Neighboring farmers advised Mr. Donaldson to try attracting the beetles at night with a light, but experiments were not satisfactory. An ordinary lantern in the field attracted none whatever, while an examination showed them to be working on nearly every hill, sometimes several upon one. Mr. Donaldson then tried hand-picking. He went over the field twice and sometimes three times every night, and kept it up for two weeks. Great numbers were destroyed, but the crop was ruined.

The distended May beetle differs from the ordinary May beetle of the North (*L. fusca*, Frohlich) quite obviously in the swelled appearance of the posterior end of the abdomen and in the shape of the thorax, as is shown in fig. 5, Plate V. The remedy customarily in use for *L. fusca*, when it has become sufficiently numerous to injure fruit trees, is to jar them from the trees into wide-spread sheets, afterwards scalding them with hot water. The method of attracting to lights has also been successfully used; the light being suspended over a tub of water or over a kerosene pan. It is possible that a more thorough trial of the lights (suggestions upon which will be found under the head of "Remedies for the cotton-worm," in a later part of this report), will show that they can

* The same gentleman, by carefully examining the earth about a single cane bunch, found several adults of *Harpalus pennsylvanicus*, Say, which were feeding upon the larvae just mentioned. He also found the larvae of a click-beetle (*Drasterius ?*), which were probably engaged in the same work; the cocoons of an ichneumon fly, supposed to be parasitic on the lamellicorn larvae; and, finally, a beetle (*Anomala binotata*) belonging to the same family with the *Ligyrus*.

be successfully used against *L. fercta*, and we should certainly advise experimentation in this direction. Should this fail, there remains nothing but hand-picking.

In pasture lands which have been badly injured by the larvae of *Lachnosterna* (ordinarily called *white grubs*) there seems to be no remedy other than giving the badly-infested field up to the hogs, which soon root out the larvae. This, of course, would pay only in extreme cases; but by such a course the numbers of the bettles would necessarily be greatly lessened, and the double injury of the two forms prevented.

DIBOLIA AEREA, Mels. (*Habits of larvae*).—Early in March of the present year, specimens of larvae infesting turnips were received from Mr. J. S. Newman, of the Southern Enterprise, of Atlanta, Ga. The larvae were found burrowing into the leaf stems as well as into the turnip itself, the eggs having evidently been deposited near the base of the leaves. It was thought at first that these might be the larvae of the striped turnip-flea beetle, as they bore a greater or less resemblance to them, but rearing to the perfect state showed them to belong to a closely-allied species, *Dibolia aerea*. As the larvæ of this insect have not to my knowledge been described, I subjoin a description:

Full-grown larva.—Length, 8mm. Slender, flattened dorso-ventrally, widest in middle, tapering slightly in both directions. General color, nearly white; head brown, darker around its margin; thoracic and anal plates a little lighter in color than the head: the second and third thoracic segments have each a pair of large, transverse, pale grayish spots and one subdorsal spot of the same color, also several small, round, darker spots: the piliferous spots of abdominal segments 1 to 6 are small, oval, of the same gray color, and with pale centers: the dorsal spots of the seventh and eighth are large and transverse oval in shape. The anal plate is beset with quite long hairs; all hairs are pale brownish. The whole body above and below is marked with numerous, very small oval, rather indistinct, grayish spots. Thoracic legs dark; only one prop-leg. The head is ordinarily sunken into the thorax for about one-third of its length. The anal plate bears at its end two upward curved (at their tips slightly incurved) minute blackish-brown horns.

The young larvae are very similarly marked, except that all markings are much clearer and darker. The head is black, the thoracic and anal plates slightly lighter; the anal horns are proportionately larger, and are blacker. The anterior half of the prothorax is white, and the thoracic plate is divided by a white longitudinal line; the body is yellowish.

THE CORN SPHENOPHORUS (*Sphenophorus zeae*, Walsh).—This destructive insect was first described by Walsh in the Practical Entomologist, II, 117. No additions have been made to Walsh's observations, so far as we are aware.

Specimens were received the past summer from Mr. E. G. Haley, of Audrain County, Missouri. The beetles were first noticed about the first of May, and destroyed all the corn in the field. A second planting was also destroyed as fast as it came up; and the third planting was also injured, but the beetles began to disappear before it was badly damaged. The young shoots were bored through and through near the ground. This is, we think, the first notice of its injuries so far west, the principal damage heretofore having been done in New York and Pennsylvania.

Walsh was of the opinion that the beetle would only annoy farmers who lived near large streams in which there would be apt to be an accumulation of drift-wood, inasmuch as he had found the larva in decaying logs floating in water. Moreover, all the specimens which he had received were from localities very near streams. It is of importance, of course, to know if this inference be true, or whether, as we suspect, the larvae will also be found in other situations. As bearing upon this point, we quote from Mr. Haley's reply to our inquiries:

The field in which they appeared is meadow and has been in meadow thirteen years, was broken up this spring. It is dry land, sufficiently rolling to drain well. There is no stream of water near and no swamp lands in the neighborhood. The insects show no disposition to travel and have done no damage on adjoining farms. I hear of one locality in Boone County where they have appeared on clover soil broke this spring and planted to corn.

This, it seems to us, quite conclusively refutes Walsh's inference, as it is evident that there is no neighboring stream or swamp; and did the beetles come from a distant water-course, neighboring farmers would also have been troubled. With so slight a knowledge of the insect's life history it is impossible to suggest remedies.

THE IMBRICATED SNOUT BEETLE (*Epicaerus imbricatus* Say) [Plate VI, fig. 2].—This variable insect has been developing new habits the past season in the State of Tennessee. Riley, in his third Missouri report, states that it does considerable injury to apple and cherry trees and gooseberry bushes by gnawing the twigs and fruit. Its injuries have been confined almost exclusively to the country west of the Mississippi or the States of Missouri, Kansas, and Iowa.

This year, however, specimens were received on the 1st of June from Mr. C. W. Hicks, of Madisonville, Monroe County, Tennessee, the easternmost part of the State, with the remark that they were injuring *onions*. Onion stalks accompanied the specimens and were riddled with holes gnawed by the beetles. Later the same gentleman forwarded to the department a letter from Mr. Thomas G. Boyd, seedsman, of Sweetwater, Monroe County, who stated that he had a field of two acres of onions, and one-fourth of the crop was ruined by this insect. He also stated that the beetles made their appearance on all his early vegetables as fast as they came up; he first noticed them upon his onions in February. They destroyed *radishes*, *cabbage*, *beans*, *watermelons*, *muskmelons*, *cucumbers*, *squashes*, *corn*, and *beets*. Pease, parsnips, carrots, and tomatoes were not touched. Many of the kitchen gardens in the vicinity were also infested by the same insect. Mr. Boyd's method of dealing with them was by hand-picking. In this way, though at a considerable expense, he managed to save several of the leading varieties of vegetables.

The early history of this insect is not known at all, and until it is known it will, of course, be impossible to recommend any other remedy than that which Mr. Boyd has already tried, namely, hand-picking.

From this remarkable occurrence on so many new food plants so far east, this insect becomes of the first importance, and the eastern market-gardeners may ere long have a new foe to contend with.

THE SWEET POTATO ROOT BORER (*Cylas formicarius*, Olivier).—Specimens of this insect in the adult state were received from J. W. Curry, of Manatee, Fla., July 8, 1878, with the statement that it "seems to threaten the destruction of the sweet-potato crop of this county." Mr. Curry was unable to give details respecting the habits of the insect, as he received the specimens from a planter residing some distance from Manatee. February 20, 1880, I visited the locality in question, hoping to be able to make a thorough study of the pest. But I found that Mr. Gillett, the planter referred to above, had dug his sweet potatoes a few days previous on account of the ravages of this insect. I was informed that the injury caused by this beetle was very great. In some fields nearly the whole crop was said to be destroyed.

The beetle is somewhat ant-like in form, as is shown in Plate VI, fig. 1. The color of the elytra and of the head and beak is bluish black; that of the prothorax is reddish brown. The yellowish-white oval eggs are laid in small cavities eaten by the parent beetles near the stem end of the tuberous roots. The milk-white larvae bore little tunnels through the

root in all directions, so that the vine dies; and frequently the entire potato is tunneled; these burrows become filled behind the larvae with excrement. When about to assume the pupa state, the insect forms an oval cavity at the end of its burrow, where it undergoes its transformation.

At the time of my visit to Manatee County, in February, only the perfect insects could be found. On the 17th of May, potatoes containing eggs and beetles with a few pupae were received from Mr. Curry. In our breeding-jars these underwent their entire transformation from egg to imago in about thirty-one days, of which eight days were passed in the pupa state. From this it appears that during the present season there have already been at least three generations, and it is impossible to say how many more may appear.

No remedy can be suggested until more is learned respecting the habits of the insect, except to dig the potatoes as soon as they are found to be infested, and feed those containing insects to cattle. The species is widely distributed. Le Conte reports it from Cochin China, India, Madagascar, Cuba, and Louisiana. I now add Florida.

DESCRIPTIVE.

The eggs are broadly oval and somewhat narrowed at the attached end; their greatest diameter is about .65mm ($\frac{1}{40}$ inch); surface is not polished, but shows slight granulation, and a faint appearance of division into facets. In color they are yellowish white.

The full-grown larva is 6mm (.23 inch) long, quite stout, with the lateral edges somewhat mammillated. The general color is pure white, but the head is light brown, and the mouth parts dark brown. No hairs are perceptible to the naked eye, but a few delicate sparse bristles can be seen under the microscope. Each of the thoracic segments is furnished ventrally with a large broad tubercle, in place of a pair of legs; the abdominal segments are smooth.

The pupa is at first of the same color as the larva, but gradually grows darker. It resembles much in form the adult beetle. The legs are drawn up in such a way that the knees extend out behind the thorax, those of the first pair being particularly prominent. The wings and wing cases are narrow and short, and are brought around to the ventral side of the body. The beak is folded down upon the breast. The anal segment is furnished with two backward and outward curved horn-like projections. On the top of the head are several small tubercles from each of which projects a slender hair.

PROTECTION AGAINST THE GRAPE CURCULIO.—The plan of Mr. Bateman, of Ohio, of inclosing grape clusters in paper bags as a protection against curculios and birds seems to be coming into great favor. The method is simply to slip a bag of sufficient size over the bunch when the grapes are one-third grown, and secure it by sticking a pin through the folds at the neck. A slit should be made in the bottom of the bag to allow the water to run out, which otherwise, in case of a storm, would collect and either rot the grapes or burst the bag. Grape-growers who have experimented with this preventive praise it in the highest terms. A much greater perfection of the cluster is attained at a slight expense. It is also stated that in addition to being kept free from birds and insects, the bunches thus inclosed are less liable to mildew than those left in the open air.

FULLER'S ROSE BEETLE (*Aramigus fulleri*, Horn).—This insect was figured and described by Professor Riley in the report of this department for 1878. During the past year a few additional facts have been learned respecting it. Specimens were received December 13, through the editors of the Pacific Rural Press, from San Diego, Cal.,

showing that the species occurs from the Atlantic to the Pacific. The California specimens were accompanied by the following note:

> I send you specimens of a small brown beetle, which is very destructive to dracaenas (and palms lightly), oranges, Cape jessamine, and achyranthus, in the order named, although he will take breakfast on almost anything that comes handy.—J. M. ASHER, San Diego, Cal.

A wire-worm or click-beetle larva was found preying upon the larvae of this beetle in our breeding cages. We did not succeed in rearing the larva to the perfect state, but believe it to be the larva of *Drasterius amabilis*, Lec.

NUTTALL'S BLISTER-BEETLE (*Cantharis nuttalli*, Say).—This is a large and very beautiful insect, of a bright green color, with golden-purple wing covers. Plate VI, fig. 6 represents its size and form. The species is a western form; its habitat extending from the Mississippi River to the Rocky Mountains. I received specimens from William H. Leverett, of Fargo, Dak., July 18, through the kindness of the secretary of the Elmira (N. Y.) Farmers' Club. Mr. Leverett states that this beetle is very destructive to beans, and that "it comes in quantities, alights on the beans, eats the bud and entirely spoils the beans."

In case this pest becomes abundant it will be well to try the same remedy for it that is used against the different species of blister-beetles that attack potatoes in the east, which is to drive them into windrows of straw and then kill them by burning the straw; or, as they frequently occur in swarms, they may be caught in large numbers by a hand net and then destroyed.

It should be noted that, although this insect now appears to be a pest, were its larval habits known we might regard it differently. The larvae of several species of blister-beetles have been known to feed upon locust eggs; and this species may yet be added to the list of beneficial insects. And even now, possessing, as it doubtless does, the same vesicating powers exhibited by its congener, the Spanish-fly (*Cantharis vesicatoria*, Linn), it should be classed among the useful products of the country.

THE CROW BLISTER-BEETLE (*Epicauta corvina*, Lec).—This is another western form. It is similar in form to the preceding species, but it is of a deep black color, which suggests its specific name. Specimens were received from Mr. F. A. Wentz, of Kinsley, Kans., June 27, with the statement that they were injurious to potatoes. As to remedies, what was said respecting Nuttall's blister-beetle will probably apply equally as well to this species.

THE BLACK BLISTER-BEETLE (*Epicauta pennsylvanica*, De Geer).—This beetle is also of a deep black color; but it is much smaller than the preceding species, measuring from three-eighths inch to one-half inch in length (9^{mm}–12^{mm}). Specimens were received from Mr. P. P. Light, of Osborne, Ohio, September 1, with the note that they were eating up all of his sugar beets. This insect is often reported as doing damage to potato vines, and is found frequently on the flowers of golden-rod; but I can find no recorded instance of its proving destructive to beets.

The same remedies can be used for this insect as for other blister-beetles.

This is one of the species of blister-beetles the larva of which was found by Professor Riley to prey upon the eggs of the Rocky Mountain locust (*Caloptenus spretus*); and the medicinal properties of this beetle have been proven to be quite as good as those of the Spanish-fly of commerce.

In Southern Europe, especially in Spain and Italy, Spanish flies are collected in great numbers for exportation. The method of preparing

them for market is as follows: After catching them by shaking them off from trees into sheets, they are plunged into vinegar diluted with water or exposed in sieves to the vapor of boiling vinegar to deprive them of life; then they are dried in heated rooms or in the sun. In some localities the collectors put the beetles, when first caught, into bags, where they are left until they die; they are then dried in the sun.

Our native blister beetles might be prepared in the same manner. The fact remains, however, that they are now of no commercial importance. It is difficult to decide whether the fault lies in the conservatism of the apothecaries, who will purchase only the Spanish-fly because it has been used for centuries, or in the people, by neglecting to bring them into market.

*THE GREEN CLOVER-WORM (*Platyhypena scabra*, *Fabr.*).—The adult form of this larva has long been known as common in almost every part of the United States. In spite of the dissimilarity in form and color between it and the cotton-worm moth (the only resemblance being in size), it was perhaps more frequently sent during the winter months to the department as the true Aletia than any other moth; by which two facts are learned: that it is common South, and that the insect customarily hibernates as a moth. During the winter of 1878–'79 it was very abundant in the District of Columbia, flying on warm, sunshiny days.

During the summer there were found abundantly upon clover rather slender green worms, which proved to be the larva of this species. They were so common that in many places one could hardly make a swing of the beating net through the grass without capturing one or more of them. The full-grown larva was 16^{mm} ($\frac{5}{8}$ inch) in length. When ready to transform, it webs together several leaves and changes to a brown pupa. The moths of the first brood issued about the middle of June, and the full-grown larvae of another brood were found August 15. There are, then, certainly two, and perhaps three, broods in a season. The larva is very similar to that of a clover-leaf roller, *Tortrix incertana*, Clem., so much so, that it is very difficult to distinguish them; it is very quick and jerky in its motions. We submit the following technical descriptions of the larva and pupa:

PLATYHYPENA SCABRA, Fabr.

Larva.—Length when full grown 16^{mm}. Color, dark yellow-green, with a narrow subdorsal and lateral whitish line. Head, prothoracic and anal plates of the same color as the body, but glassy. Whole body with sparse dark hairs, longer on anal plate. Spiracles dark-brown; tips of prolegs and mouth parts brown. Sides subparallel; greatest width 2.6^{mm}.

Pupa.—Rather stout, dark mahogany-brown. Wing sheaths and crural sheaths closely soldered; the former obtusely rounded and extending to the end of the fifth abdominal segment. Stigmatal tubercles quite prominent. Dorsum of thorax and wing sheaths coarsely shagreened. Dorsum of abdominal segments rather sparsely punctulate, the posterior border of each segment being smooth and shining. The anal segment at its end is furnished with several (a variable number) minute recurved hook-like spines. From the apex of the head to the end of the fourth abdominal segment the dorsum is elevated into a slight ridge, more marked upon the abdominal segments than upon the thorax.

THE GREATER LOCUST LEAF GELECHIA (*Gelechia pseudacaciella*, Cham.)—This insect has been very common on the locusts in the vicinity of Washington during the past season, which leads us to make a

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* *Hyblaea scabra* Fabr., *Crambus crassatus* Haw., *Hypena obesalis* Steph., *Hypena erectalis* Guen, female, *Hypena scabralis* Guen, male (see Lintner in Canadian Entomologist, v, 81). *H. erectalis* var. *subrufalis* Grote, Trans. Am. Ent. Soc. iv, p. 102. (Grote's List of the Noctuidae misprints this last volume as 3.)

note of the appearance of the immature forms and their work. The egg is laid on the under surface of the leaf, and the newly-hatched larva, which is green in color, with black head and thoracic plate and six longitudinal dusky stripes, the two middle ones faint posteriorly, spins a slight web, and feeds upon the lower leaf tissue until nearly half grown. It then usually attaches a second leaf to the one upon which it is at work, and lives between the two until nearly grown. Frequently a migratory fit seizes upon one of these larvae, and it not unfrequently is found in the mines of one of the other locust tineids. Indeed, Mr. Chambers states (Canadian Entomologist, vol. iv, p. 107) that he has seen one in the act of boring into the mine of *Lithocolletis robiniella*. He also states (American Entomologist, vol. iii, p. 60) that the larva of the *Gelechia* not infrequently eats the pupa of the *Lithocolletis* in such cases. In cases where the young larvae of the former insect are found in the mines of the latter, however, it seems probable that it is more the result of accident than design. The full-grown larva is large and stout, measuring 18 to 19^{mm} (about $\frac{3}{4}$ inch) in length. It is quite round and plump, and tapers considerably from the third abdominal joint to the anus. The head is reddish brown; the first thoracic segment is pale greenish-brown, with its anterior margin whitish; the body is yellowish, with six dusky longitudinal stripes, of which the two lateral ones are broadest; frequently the two middle ones are very faint. The cocoons of the late summer brood were found upon the ground under the tree. Each is about 20^{mm} (.78 inch) in length, somewhat flattened, and rounded at each end, and is composed of light-gray silk. The outside is closely covered with one or more leaves, every edge of which is closely fastened down, all the superfluous material being cut off. Whether the larva descends to the ground to form this cocoon, or whether it is spun upon the tree and falls with the leaves, or is cut off after completion, we cannot definitely state, but the latter seems most probable. The larva does not transform immediately after finishing its cocoon, but passes the greater part of the winter in the larval stage, changing to a pupa a few weeks before the exit of the moth. One larva which spun up September 21 left its cocoon on January 11 for some cause or other and wandered around the breeding cage until it died. The pupa, with the exception of being larger, resembles very closely that of *G. robiniella*. (See page —.) The moth, which issues in late spring, has an expanse of wing of about 61^{mm} (.63 inch), and is somber in color. The fore wings are dark slate, flecked with brown and white. The hind wings are of a very pale slate, whitish towards the base.

It will at any time be easy to lessen the numbers of these insects by burning over the grass and leaves under the trees during the winter, thus destroying the chrysalides. Two ichneumonid parasites have been bred from this insect, which have been determined by Mr. Cresson, as *Linneria annulipes* Cress., and *Perilitus communis* Cress.

THE CODLING MOTH (*Carpocapsa pomonella*) in TASMANIA.—A document has been received from Hobartown, Tasmania, which embodies the report of a select committee of the house of assembly, "to inquire into the destruction of fruit by the codling moth." The testimony of several prominent fruit growers is given, and in the appendices a varied testimony, chiefly from American sources. The final recommendations of the committee are as follows:

REPORT.

Your committee have held two sittings since Parliament met, and after a careful review of all available information collected, both from American and Tasmanian

sources, and after taking the evidence of Messrs. Cronly and Latham, have unanimously come to the following conclusions:

1st. That the time of year is such that, unless immediate action be taken, another whole season will be lost, and the ravages of the pest greatly extended.

2d. That in the south of the island, at least, the *Carpocapsa pomonella* is limited in its distribution, and offers a fair chance for its eradication if energetic steps are at once taken.

3d. That no individual effort, or continuation of the same, will be of any avail unless assisted by legislative enactment.

4th. That on the 1st February, 1880, your committee recommend there be appointed an inspector or inspectors, whose duty it shall be to see that all diseased fruit is removed from the orchard and destroyed.

5th. That at the same time every tree in an infested garden must be carefully bandaged and periodically examined, at intervals of not more than fourteen days, so that any grubs that may have already escaped from the fruit-trees be then trapped and destroyed. Later on in the year the trees to be cleared of loose old bark, and lime or other grub-destroying wash applied.

6th. To meet the necessary outlay, your committee propose that a tax of not exceeding one penny per bushel per annum be levied upon all apples, pears, and plums, such tax to be paid by the grower upon the net marketable product.

7th. That if, after being warned, any person refuse to remove and destroy diseased fruit, and take other precautionary measures, it shall be done at the sole cost of the occupier of the land.

8th. That on this report being approved by Parliament, the same be embodied in a bill.

EDWARD L. CROWTHER, *Chairman.*

COMMITTEE ROOM, *January* 23, 1880.

The report as a whole is one of considerable interest. We are rather disappointed, however, to see some five pages devoted to the subject of a *wash* for the codling moth, *without* the results of actual experiments, since it seems very improbable, from the known habits of the insect, that anything in the nature of a wash applied to the trunk of the tree will have the slightest effect upon its ravages.

In this connection we should like to commend the active efforts which have been made by the Michigan entomologists and by the Pomological Society of that State to improve the quality of their apples by reducing the ravages of the codling moth. It is stated that the reputation of Michigan apples in the southwestern markets has greatly changed for the better within the past year or two in consequence of these efforts. The present year the society has offered premiums of $50 and $25 for the best directed and most persistent efforts to destroy the insect, and it is hoped that the offer will lead to many interesting and valuable reports of experiments, and its results will help to show to a greater or less extent the value of concerted action.

THE PEACH-TREE BORER (*Aegeria exitiosa* Say).—Observations made last spring showed that upon May 10 many of the moths had already issued, and were engaged in oviposition. The average length of the egg is .56^{mm} (.02 inch). Its width is a little over one-half its length. It is subellipsoidal in form, and one end only is either squarely or somewhat obliquely truncate. Its color is a beautiful yellow-brown, and its whole surface is so sculptured as to have the appearance of being laid with irregularly shaped paving stones; having just the appearance of what the histologist calls pavement epithelium. Each of the "slabs" is covered with grooves of an irregular form. The eggs are deposited singly and are stuck to the surface of the bark on their sides by a gummy secretion. The female makes no effort to discover a crevice in which to thrust the egg. One female was seen to deposit upwards of twenty eggs upon different parts of the trunk of one tree, usually about one or two feet from the surface of the ground, in the space of about one hour. The young larvae when just hatched are very active and

have many long, stiff bristles on their bodies. Instead of boring through the bark they seek a crack, and an almost incredibly small one will suffice.

An article has been going the rounds of the agricultural journals advising a new remedy for the peach-tree borer. We quote from the Kansas Farmer, March 28, 1880:

> The best way to prevent the borer from getting into your trees, and the best because easiest, speediest, and quickest of all preventives, is to scrape with a hoe the soil from around the collar of the tree down to the branching of the roots, and bind a handful of straight straw around the body of the tree; securing the straw in place with a small cord, return the soil, which will keep the butts of the straw in place. Renew the straw every spring, and be careful that the straw covers the bark, leaving no gaps exposed, and a peach-tree borer will never disturb the orchard. We practiced this plan on a peach orchard for several years, and never had a tree thus protected injured, while one left exposed was sure to be attacked.

The straw certainly would be efficacious in keeping the moths from depositing their eggs on the bark which is thus protected, but higher up the tree would not have the same freedom; and it is not uncommon that the larvae of this insect are found boring into the trunk of a tree several feet from the ground. Inasmuch, however, as it would be much easier to watch for the borers and destroy them on the upper part of the trunk than at the base, this remedy might prove of advantage.

Four species of parasites have been bred from the peach-tree borer the past season—two chalcids and two small ichneumonids, the one belonging to the genus *Microgaster* and the other to the genus *Bracon*. These will be described and figured in a future article.

ANARSIA LINEATELLA Zeller.—This insect has long been known as a serious pest in peach orchards, destroying the terminal twigs of the trees. The young caterpillar begins its work in the spring, at the time or soon after the shoots begin to grow. These, when from one-half inch to one inch in length, are punctured at the base and are eaten off completely. The leaves of the bud unfold and then wither. The twig, although severed, does not drop off, but is held in place by the gummy substance which exudes from the wound. Occasionally all the twigs on a tree are thus destroyed. This insect has also been found by Mr. Wm. Saunders boring into the crown and roots of strawberries in Ontario.* And during the past summer I found the peculiar reddish larvae in peaches which were grown on Blackistone Island, Virginia. A search revealed them also in peaches on the department grounds. The larva leaves the peach before transforming, and suspends itself to the outside of the fruit, spinning no cocoon at all. The twig-inhabiting individuals mature in this latitude during May and June. The fruit-inhabiting larvae are found during the latter part of July and in August, and mature during September. It thus appears that the species is two brooded: the early brood feeding in the terminal twigs and buds, while the later brood inhabits the fruit.

As a remedy, the trees should be examined early in May, and all dying twigs pruned and burned, thus destroying the larvae.

An interesting chalcid parasite has been bred from this insect, which we have not had time to describe and name for this report.

THE LIME-TREE WINTER-MOTH (*Hibernia tiliaria* Harris).—I have received quite a full account of this insect from Mr. D. W. Coquillett, of Woodstock, Ill., but for want of space I am compelled to condense it briefly in the form of this note.

It seems that this insect has been doing considerable damage to the orchards in Northern Illinois during the past few years. Many species

*Annual Report Ent. Soc., Ontario, 1872.

of trees are injured by it. The worms appear in May, and eat the foliage of the apples, elms, &c., until they attain their full growth in late June. They then descend into the ground and transform three or four inches below its surface. The moths issue in October, and the *wingless* female ascends the nearest tree, where copulation with the *winged* male takes place. The female is furnished with an extensile ovipositor, with which she thrusts her eggs under loose bark and in crevices on the trunk and large limbs. The sudden appearance of these insects in orchards widely separated from previously infested trees is accounted for by Mr. Coquillett by the supposition that, while in copulation, the male flies with the female.

Among the natural enemies of this insect, the ones most frequently met with are the Fiery and the Rummaging Ground Beetles (*Calosoma callidum* and *C. scrutator*). Mr. Coquillett states that he has frequently found the latter climbing about in the tops of trees searching for the caterpillars. The blue-jay is mentioned as being among the most effective of the bird enemies of the worms.

As to remedies, the bandages and traps used for the ordinary spring canker-worm will answer admirably, though, owing to the somewhat different history of the insect, they should be applied at a different time in the year. The object being to prevent the wingless female moth from ascending the tree, the bandages should be placed in position by the first of October and continued for six weeks or more. Mr. Coquillett has found that tarred-paper bands are as serviceable and cheap as anything that can be found. Ordinary carpenters' sheathing-paper is the best. A strip of the ordinary width should be tied around the base of the tree, leaving no part of the trunk exposed between the paper and the ground. The tar with which the paper is then smeared should be mixed with a little castor oil to prevent it from hardening too rapidly.

The lime-tree winter-moth is represented in all stages at Plate VI, fig. 4. The colors of the larva are bright yellow, lighter beneath, with ten crinkly, longitudinal lines down the back, and a rust-colored head. The male moth has rusty, buff fore wings, while the hind wings are much lighter. The female is grayish, with a parallel row of black patches down its back.

THE RESIN INHABITING DIPLOSIS (*Diplosis resinicola* O. S.).—In 1868 Mr. Sanborn exhibited before the Boston Society specimens of a "Cecidomyious larva," which he had found feeding in companies of thirty or forty in the pitch exuding from wounds in the bark of *Pinus rigida*. "Whether they were the prime cause of the injury to the tree was not plainly apparent." (See Proc. Bost. Soc. Nat. Hist., XII, 93.) In the proceedings of the Entomological Society of Philadelphia, 1871, p. 345, Osten-Sacken records the discovery of similar larvae in the exuding resin of *Pinus inops* at Tarrytown, N. Y. These he reared to the perfect state, and gave the species the name *Diplosis resinicola*.

Early in May the two or three year old branches of *Pinus inops* in the vicinity of Washington were observed to be quite extensively infested by these insects, which were then in the larva state and actively feeding. They shortly turned to pupae, and the first midge emerged May 26. On June 11 larvae of the same species were found upon the twigs of *Pinus rigida* at Ithaca, N. Y. Pupae were also found in the same twigs, and June 13 the first midge issued. In February, 1880, I collected specimens of similar larvae at Orange Lake, Florida, on twigs of *Pinus taeda*, which, upon the appearance of the adults on March 1, were found to be of the same species.

Plate VI, fig. 5 shows well the work of this insect. The lumps of exud-

ing resin may contain from two to thirty of the larvae, which, when full grown, measure on an average 6^{mm} (about one-quarter of an inch) in length. While still feeding they are pale orange in color, but, after ceasing, they become of a bright orange. The spiracles of the anal segment are at the summit of two protruding tubercles, and around each is a small whorl of four fleshy papillae. The other spiracles are small and black. The larvae are much elongated, and are widest at the 6th segment; the under sides of segments 1 to 7 are furnished each with two transverse rows of short black or brown spines, probably for locomotive purposes. While burrowing in the bark and resin the anal tubercles are always at the surface. When, however, the larva contracts to pupate, the end of the body is drawn in, but an open channel is left so that the air has free access. When about to give out the adult, the pupa works its way to the surface of the resin and protrudes half its body, so that there is no danger of the midge becoming fastened in the sticky gum. Dried lumps of resin fairly bristling with protruding pupa skins are a common sight on trees affected by these insects.

The adult insect is large, measuring 9^{mm} (.354 inches) in wing expanse. The head is blackish, the thorax gray, and the abdomen dark red. The male antennae are 26 jointed, with alternate single and double joints, all pedicelled; the female, 14-jointed. The main peculiarity of the adult form is in the remarkable gibbosity of the head, the eyes joining together at the summit and covering nearly the whole head. The wing venation and other points are shown in the plate. The resin exuding from the wounds on *P. inops* is perfectly clear, and permits one to count the number of the larvae and to watch their every motion.

Upon the Loblolly pine (*P. taeda*), however, it is milky, and the presence of the insect cannot be ascertained without opening the mass.

We have as yet no data upon which to state definitely whether the eggs of the midge are laid upon the uninjured bark, and it is the work of the larvae in the bark which causes the resin to exude, or whether it is only in resinous exudations, caused by a bruise or by the work of some other insect that the eggs are laid. In the clear lumps on *Pinus inops* the larvae are always observed with their heads applied to the abraded bark.

Somewhat similar, though evidently distinct, larvae were found feeding in the resin exuding from the wounds made by the larva of *Retinia Comstockiana* in the twings of *Pinus rigida*. It is probable that they may be Osten-Sacken's *Cecidomyia pinus-inops*, but it is difficult to say positively, as his description of this species is so very indefinite.

A NEW WHEAT-FLY (*Chlorops proxima* Say).—April 19, 1880, specimens of an insect infesting wheat were received from Mr. E. Schneider, Fairview, Todd County, Kentucky. The wheat had been doing well until within a few weeks of the time of sending, when it began to turn yellow in spots. Examination showed the insects working between the blades and seemingly trying to reach the first joint. While some injury had been done to the crop, it was still not at all seriously affected, as there were in nearly every case enough uninjured and quite vigorous stalks left in each plant to insure a good crop.

The first specimens received were dried up greenish-yellow larvae. When alive they had evidently been fat maggots of about 7^{mm} (.27 inch) in length. A few days later additional specimens of the infested wheat were received, in which were found several puparia (corresponding to the so-called "flaxseed" state in the Hessian fly). These were of a light yellowish color, and the outer skin was so transparent that the inclosed pupa could be readily seen. They were about 6^{mm} long by 2^{mm} broad.

Two adult flies issued on May 10, and proved to be specimens of *Chlorops proxima*, described many years ago by Say from specimens collected in Indiana. So far as can be ascertained, the habits of this fly have not been recorded, though they might well have been suspected from the habits of allied known species. In his second New York report, Dr. Fitch described eight species belonging to the same family (*Oscinidae*), and stated that he had found them in abundance by sweeping the wheat with a net. In Europe closely allied flies have always been among the most prominent enemies of the grain crops. As long ago as 1750 Linnaeus estimated that the damage done by *Chlorops frit* to the barley crop in Sweden amounted to one hundred thousand golden ducats (half a million of dollars) annually.

The species under consideration was called *proxima* by Say on account of its very close relationship with the destructive *Chlorops lineata** of Europe, the only distinguishing mark of importance being that the back of the abdomen in the American specimens is yellowish, while in the European individuals it is pale greenish black. The ravages of *C. lineata* with those of other allied insects in France were the occasion of the appointment of M. Olivier by the Society of Agriculture in 1812 to investigate their habits. M. Olivier was followed in this work by M. Audouin, Herpin, and Guerin-Méneville. As the result of their investigations it was discovered that the adults of *C. lineata* were most abundant in late May or early June, when they paired and the females deposited their eggs upon the wheat stems just below the sheaths of the ears, which are then forming. The larvae made small external burrows down to the first joint, which never reached the heart of the stems, but which deformed the heads. Upon reaching the first joint the larvae had attained full growth and transformed at the ends of their burrows. In September the adults again made their appearance and, after living many weeks, coupled and deposited their eggs upon the rye and corn quite recently sown, the larvae feeding upon and deforming the central shoot, living between the stem and the sheath. The remedies advised were, first, hand picking, pulling up and destroying the infested plants; only practicable upon a very small scale; second, rotation of crops. Curtis has advised dusting with soot or lime upon the appearance of the flies in autumn to prevent the deposition of eggs.

As regards *C. proxima*, it will in all probability be found to be double brooded, one brood upon winter wheat and the other upon spring. Its habits and, more particularly, *its periods* are not well enough known to enable us to suggest a remedy, but it is well worth careful study. Wherever it is found, the date of the appearance of the flies both in the fall and spring should be carefully noted, as it is possible that late or early sowing would affect its increase. The colors of larva and pupa have already been given; the adult is bright yellow with the darker portions black. Its body is 4.3mm (.134 inch) long, and the wings when closed extend for a considerable distance behind.

THE TEXAS HEEL FLY.—Specimens of a so-called Texas cattle heel fly were received during the winter from Mr. E. K. Carr, of Kerrville, Kerr County, Tex., and proved to be nothing more than the common bot fly of the ox (*Hypoderma* (*Oestrus*) *bovis* Deg.).

THE WOOLLY APPLE LOUSE (*Schizoneura lanigera* Hausm.)—To the excellent article on this insect by Dr. Cyrus Thomas in his last report (Transactions of the Department of Agriculture of Illinois, 1878, Vol. XVI, p. 128) we have not much to add. Some few observations, however,

* Considered by Gmelin to be synonymous with *Chlorops taeniopus* of Curtis, *C. nasuta* Meigen, and *C. glabra* Westwood.

made during the past season, may here be given as supplementing that paper.

In Washington during the past winter the trunk form has maintained itself upon the trunk throughout the whole winter without the intervention of a winter egg, and the root form has done the same. The winter, however, has been an unusually mild one.

The winter egg was found on several occasions during the winter in crevices of the bark over which a colony had been stationed during the summer. It was a rather long ovoid, measuring .322^{mm} (.127 inch) in length and was very similar to the winter egg of *Colopha ulmicola* (Fitch), as described by Riley in Bulletin No. 1, Vol. V, Hayden's Survey.

This egg was laid, as Professor Thomas supposes, by a wingless female, differing from the ordinary agamic form to a certain extent. These females we only know from finding their skins around the winter egg, since they often die without depositing it. The males we have not seen.

We would take exceptions to the following statement in Dr. Thomas's article:

> So far as the method of propagation is concerned, it has been shown by Dr. William M. Smith, of New York, that it differs slightly from the true Aphides, in that the young larva produced by the agamic females are inclosed in the thin egg-shaped covering heretofore mentioned, from which they have to free themselves in a manner analogous to hatching. The remains of this covering may often be seen attached to the tip of the abdomen, and is doubtless the supposed cottony secretion alluded to by Dr. Fitch in his description of the young larvae.

Mr. Howard has repeatedly watched the birth of the young of the *wingless* agamic females, and positively states that they are born without the enveloping pellicle or pseudovum. While the head and its appendages were still within the mother, he has seen the legs kicking vigorously outside. Judging from analogy, however, the young from the winged viviparous females would be born within a pseudovum, and it was probably these which Dr. Smith observed (we have no information as to where the paper was published), and from which he has drawn too hasty a conclusion. In the births which were observed, more or less of the waxy (not cottony) excretion was observed at the tip of the abdomen of the young louse from the moment that its abdomen was perceptible, thus showing that Dr. Fitch was not necessarily mistaken on this point.

That the above ground colonies are usually started by migrating individuals from the roots or from eggs laid near the ground we consider as probable, since a regular upward progression was observed through the summer, the suckers being first affected by young lice, which were seen to issue from the ground, and the higher parts of the tree at a later period. When working upon suckers, the little colonies seemed preferably to gather in the axils of the leaves, soon causing the leaves to fall off. They were also almost invariably upon the tender and greener side of a shoot, rather than upon the brown and more weather-beaten side.

As regards the natural enemies of the woolly louse, perhaps the most effective are the spiders, many of them spinning webs directly over a colony of lice and living at their ease, taking their food when they desired. The next in efficiency were the chalcid flies (*Eriophilus mali* Hald.) Plate VI, fig 6.)

The root louse syrphus fly (presumably the *Pipiza radicum* of Walsh and Riley), has also been found in considerable numbers. That the eggs of this fly are laid in the midst of the waxy excretion and not upon the bark of the tree, is shown by the fact that among a number of lice which

were carefully collected, placed in a pill-box and neglected for several days, were found two half-grown syrphus larvae, which must have been present in the egg state when the lice were placed in the box. Many Chrysopa cocoons were found in the neighborhood of the colonies, and the larvae of *Coccinella 9-notata* were quite abundant.

As to remedies, the above-ground colonies are readily destroyed by almost any of the old insect-washes. Their waxy water-proof covering, however, renders it necessary that the application, if very liquid, should be thoroughly applied. The root individuals are almost as difficult to get at as the celebrated grape *phylloxera*. A heavy, damp soil seems to be inimical to them, while in a dry, porous soil they flourish. Hence it has been recommended that the earth around the crown of the tree should be kept hollowed into a sort of a basin, in order that the water may collect there. It has also been recommended to clear away as much earth as possible from the upper roots, and pour on strong soap-suds or hot water. It is very probable that the extensive series of experiments, now being made in France for the purpose of ascertaining an effective remedy for the phylloxera, will bring to light some application which will be equally applicable to our apple root lice.

A NEW PARASITE ON THE CABBAGE PLANT LOUSE.—Numerous specimens of a small hymenopterous parasite were bred from specimens of the well known cabbage plant louse (*Aphis brassicae* Linn.), which were received from Mr. Rusha Denise, of Norfolk, Va., February 27, 1880. These parasites proved to belong to an undescribed species. They were referred to Mr. E. T. Cresson, who characterizes them as follows:

TRIOXYS PICENS Cresson (n. sp.)

Female.—Piceous or shining black, smooth and polished, impunctured: clypeus and mandibles dull testaceous, palpi whitish; antennae blackish, sometimes more or less pale beneath, 14-jointed, the joints faintly fluted or grooved, the last one longest; wings hyaline, subiridescent, stigma subhyaline: legs dull testaceous, the femora and tibiae varied more or less with fuscous; abdomen brown or pale piceous, venter pale. Length, .10—.12 inch.

Male.—Antennae longer, 17-jointed; legs black or fuscous, the anterior pair generally paler, trochanters, base of tibiae and of the tarsi dull testacecus.

Hab.—Norfolk, Va. Parasitic upon *Aphis brassicae.*

FUNGI AS INSECTICIDES.—The following results, condensed from a valuable paper by Prof. A. N. Prentiss, of Cornell University,* may be given as corroborating the results reached by the department in its experiments upon *Aletia*, and published in the Report on Cotton Insects.

The writer finds that, although the air of his laboratory and the adjoining rooms becomes filled with innumerable spores during the season when molds, yeast, and other fungi are cultivated by his classes in mycology, plants growing in the various rooms are often greatly infested with aphides and scale insects which do not appear to be subject to any disease, while on the other hand fungoid diseases not rarely attack the plants themselves. From this it appeared improbable that yeast and common molds could be made efficacious in the destruction of noxious insects: but with a view to ascertaining as many facts as possible bearing upon the subject, a series of experiments upon house plants, growing under conditions favorable to the growth of fungi, were carried on by Professor Prentiss and his assistant, Mr. Henry.

Plants infested with aphides scale insects, or red spiders were isolated in various ways and the insects counted, or, where this could not be done

* Destruction of Obnoxious Insects by means of Fungoid Growth," American Naturalist, 1880. Through the courtesy of Professor Prentiss, I have been able to study the manuscript of this paper prior to its publication.

on account of their great numbers, the insects were carefully removed from all but a few leaves, and those allowed to remain were numbered. Yeast in an active state of fermentation and from several makers was then applied so as to drench the insects and all parts of the plants; and in some cases open vessels filled with yeast were placed below the plants. In some cases the foliage of the plants was found much disfigured by brownish blotches, apparently caused by the yeast. Sometimes the insects multiplied rapidly after the application of the fungus, and a very few which died were not found to contain the spores or mycelium of fungi so far as could be seen by a careful examination with high powers of the microscope, and, indeed, this may be given as the general result of the experiments carried on where the humidity of the air was not excessive. At other times the aphides died in considerable numbers; and, when placed on pieces of moist earthenware, the dead insects developed quantities of hyphae, which were recognized by their fruit as belonging to one of the molds (*Mucor* sp.) This result is especially noticeable in an experiment (No. 5) in which the plant was placed in a close Wardian case, where the moisture alone might have caused the death of the insects, and where the torulae, covering everything, would naturally tend to assume the mucor form, and the ever present spores of molds to develop mycelium and this fruit. A test experiment (No. 9) in which aphides not subjected to the yeast treatment became covered by a fruiting mucor goes to show that too much credit must not be given to the yeast as the cause of the death.

From his experiments Professor Prentiss concludes that yeast cannot be regarded as a reliable remedy against such insects as commonly affect plants cultivated in green-houses, rooms, and parlors, while it may injure some plants by disfiguring their foliage and giving rise to molds on the jars and soil in which they are grown; but the fact that some insects are subject to fungoid epizootics renders it possible that we may yet be able to induce diseases of this nature at will.

While, therefore, the practical application of fungi as insecticides is as yet far from being an assured success, and climatic conditions must, necessarily, be always carefully considered in applying remedies of this nature, even after it is demonstrated that they can be successfully applied under the most favorable conditions, yet we believe that the subject is worthy of much careful study and experimentation, especially with a view to cultivating destructive fungi in Pasteur's fluid, sweetened paste, and other substances known to be favorable to the growth of these organisms, in which they may be extensively propagated, and with which they may be readily applied to plants infested with the insects it is desirable to destroy.

EXPLANATION TO PLATES TO REPORT OF ENTOMOLOGIST.

[When the figures are enlarged, the natural size is indicated by a hair line.]

EXPLANATION TO PLATE I.

FIG. 1.—*Heliophila unipuncta*, eggs, pupa, and adult. (Original.)

FIG. 2.—*Nemoraea leucaniae*, larva, puparium, and adult; also fore part of an army-worm showing placing of parasitic eggs. (Original.)

FIG. 3.—*Heliophila unipuncta*, larva. (Original.)

FIG. 4.—*Cicadula exitiosa*. (Original.)

FIG. 5.—*Cecidomyia trifolii*, larva, cocoons, and adult. (Original.)

FIG. 6.—*Languria mozardi*, eggs, larva, pupa, adult, and manner of work. (Original.)

EXPLANATION TO PLATE II.

FIG. 1.—*Laverna sabalella*, larva, pupa, adult, and manner of work. (Original.)

Fig. 2.—*Aspidisca splendoriferella*; *a*, leaf of apple showing work; *b*, summer larva; *c*, larva in case traveling; *d*, cases tied up for winter; *e*, hibernating larva; *f*, pupa; *g*, moth; *h*, parasite. (Original.)

EXPLANATION TO PLATE III.

FIG. 1.—Twig of grape-vine with larvae and adults of *Graptodera chalybea*. (Original.)

FIG. 2.—*Graptodera chalybea*, larva, adult, hind femur of adult. (Original.)

FIG. 3.—*Artipus floridanus*, adult and results of work. (Original.)

FIG. 4.—*Crioceris asparagi*, eggs, larva, adult. (Original.)

FIG. 5.—*Phakellura hyalinitalis*, larvae, pupae, and adults. (Original.)

FIG. 6.—*Tachina* parasitic upon the melon-worm. (Original.)

EXPLANATION TO PLATE IV.

FIG. 1.—*Nematus similaris*; *a*, egg; *b*, young larva; *c*, full-grown larva; *d*, anal segment of full-grown larva; *e*, cocoon; *f*, adult. (Original.)

EXPLANATION TO PLATE IV.—Continued.

FIG. 2.—*Corythuca arcuata*, adult. (Original.)

FIG 3.—*Corythuca arcuata*, eggs and immature individual. (Original.)

FIG. 4.—*Lithocolletis hamadryadella*; *a*, mine; *b*, young larva; *c*, full-grown flat-form larva; *d*, head of same, enlarged; *e*, antenna of same, enlarged; *f*, round-form larva from above; *g*, same from below; *h*, head of same, enlarged; *i*, antenna of same, enlarged; *k*, maxilla and palpus of same, enlarged; *l*, labium, labial palpi, and spinnerets of same; *m*, pupa; *n*, side view of pupal crest; *o*, front view of same; *p*, cocoon; *q*, moth. (Original.)

EXPLANATION TO PLATE V.

FIG. 1.—*Retinia comstockiana*, larva, pupa, adult, and work. (Original.)

FIG. 2.—*Retinia frustrana*, larva, pupa, adult, and work. (Original.)

FIG. 3.—*Lebia grandis*, enlarged and natural size. (Original.)

FIG. 4.—*Ligyrus rugiceps*. (Original.)

FIG. 5.—*Lachnosterna farcta*. (Original.)

FIG. 6.—*Gelechia pinifoliella*, larva, pupa, adult, and work. (Original.)

EXPLANATION TO PLATE VI.

FIG. 1.—*Cylas formicarius*. (Original.)

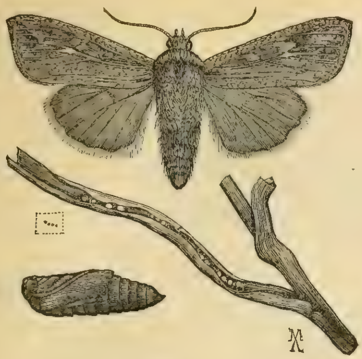
FIG. 2.—*Epicaerus imbricatus*. (Original.)

FIG. 3.—*Cantharis nuttalli*. (Original.)

FIG. 4.—*Hibernia tiliaria*, larva, adult, ♂ and ♀. (Original.)

FIG. 5.—*Diplosis resinicola*, specimens of work, adult, wing enlarged, ♂ and ♀ antennae.

FIG. 6.—*Agonioneurus mali*, and enlarged antennal flagellum. (Original.)



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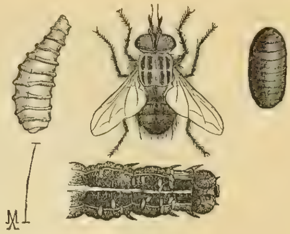

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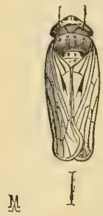

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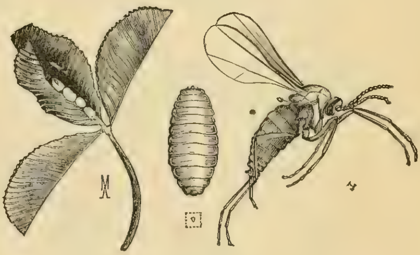

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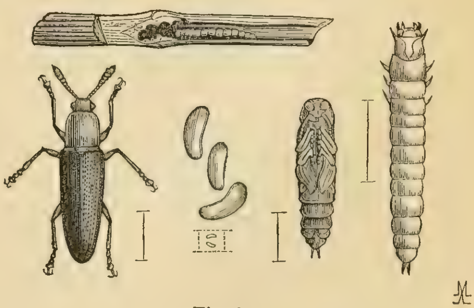

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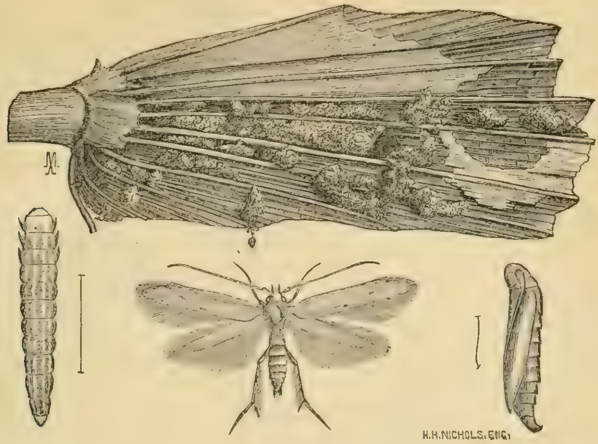

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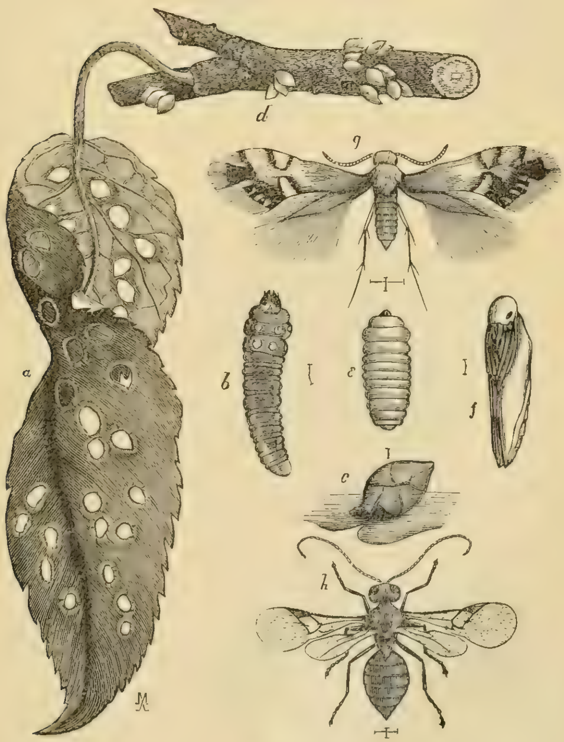

Fig. 2

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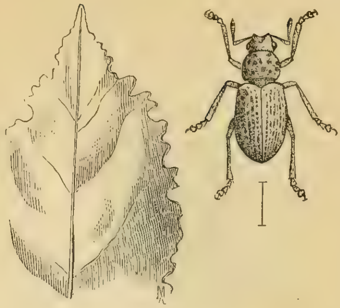

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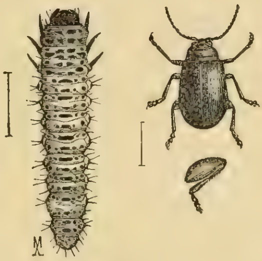

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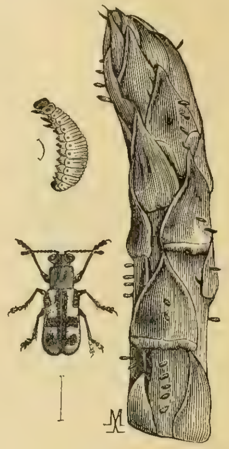

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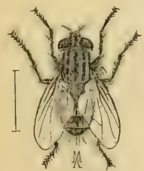

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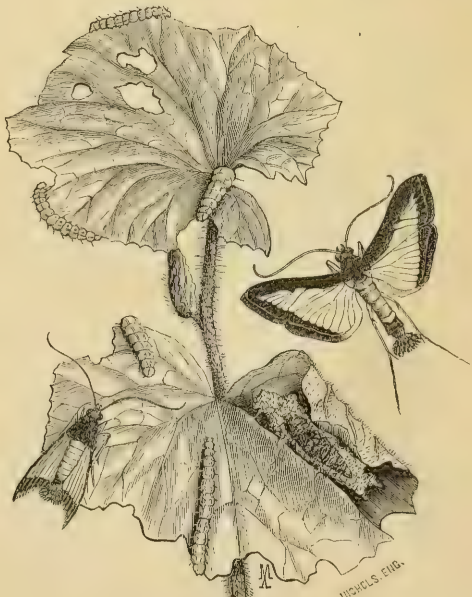

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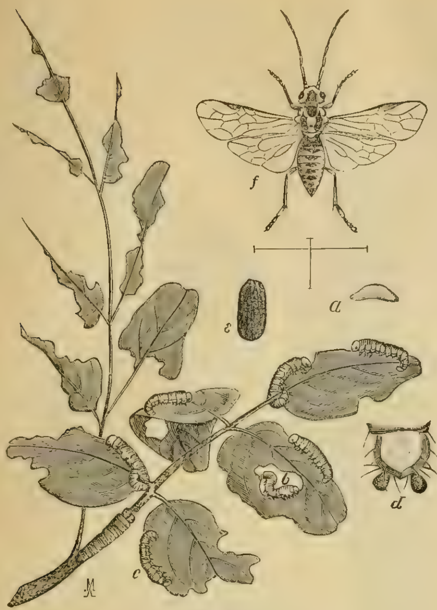

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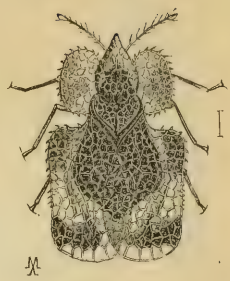

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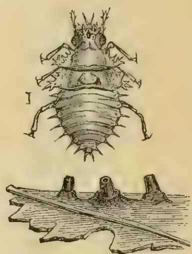

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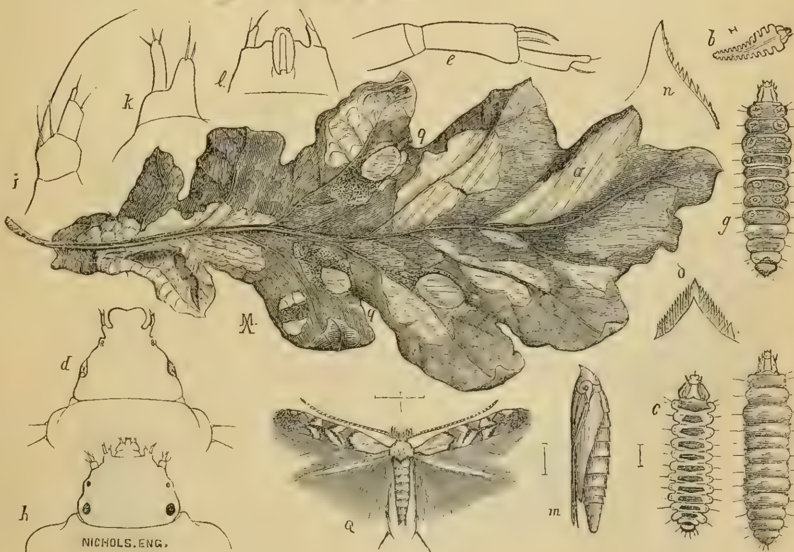

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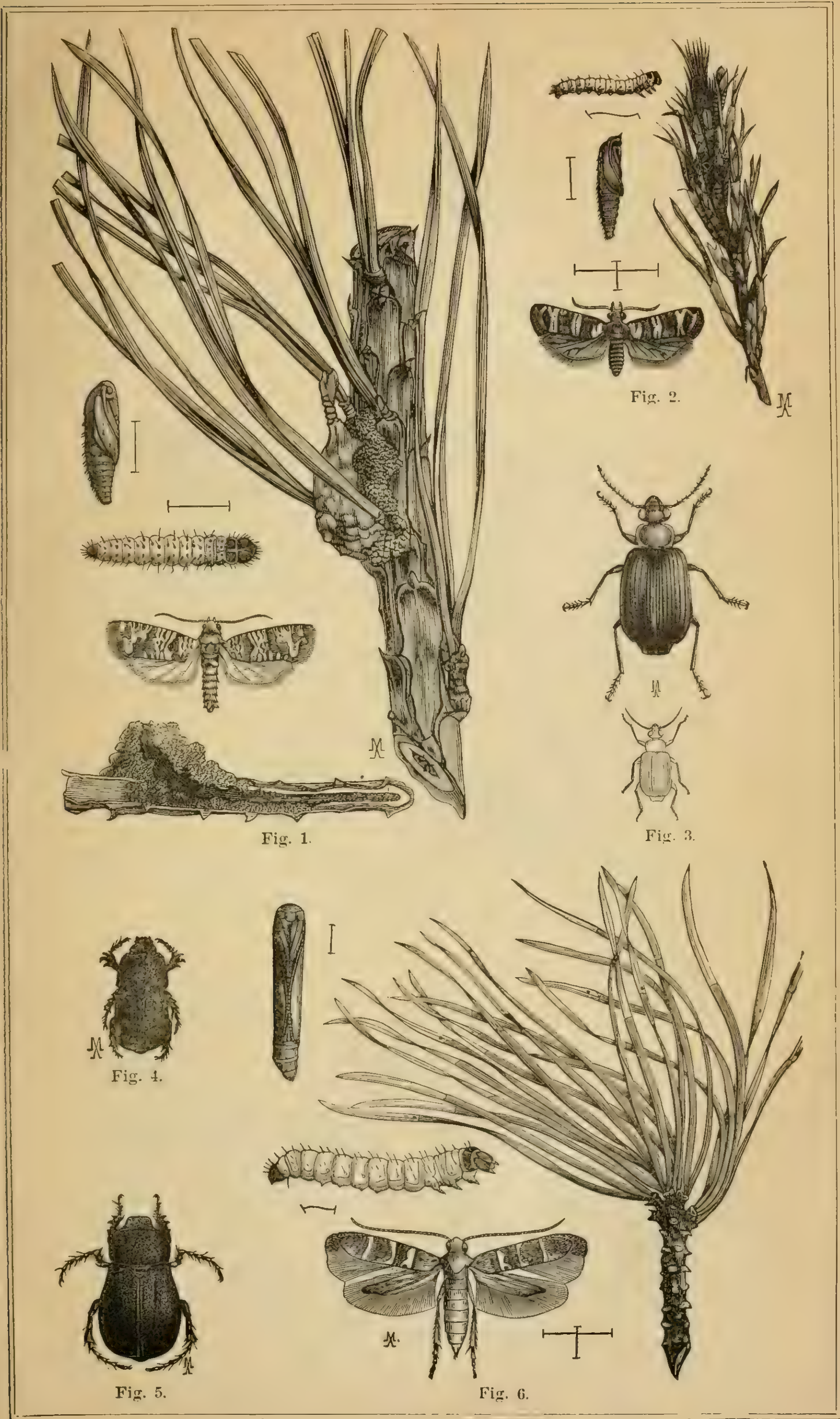

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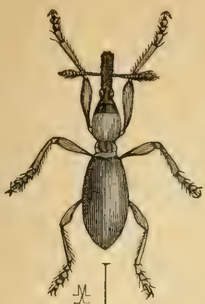

Fig. 1.

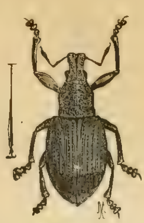

Fig. 2.

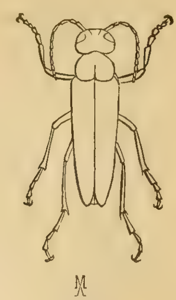

Fig. 3.

Fig. 4.

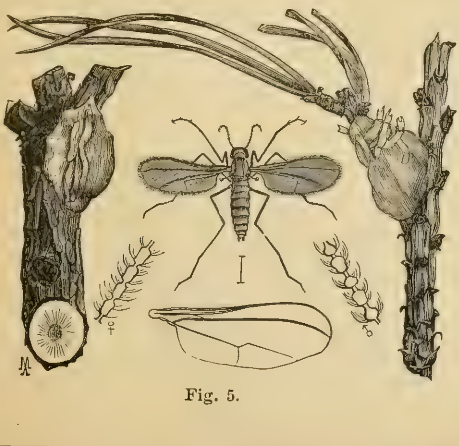

Fig. 5.

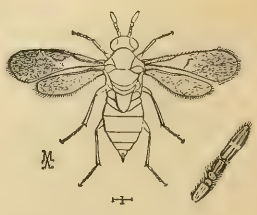

Fig. 6

COTTON INSECTS.

[The edition of the *Report upon Cotton Insects* published by this department being too small to supply the demand, we give here a *résumé* of the more important chapters.]

THE COTTON-WORM.

(*Aletia argillacea* Hübner.)

Order Lepidoptera; family Noctuidae.

NOMENCLATURE.

In glancing over the literature on the insect under consideration we find that it is known by various popular titles. The "*Chenille*" is a name which still holds in many parts of the South. It was originally introduced by the French planters emigrating from Martinique and other French West Indies to Georgia in 1801–1802, and also by the French settlers of Louisiana. Although literally signifying nothing but *caterpillar*, it has come to be applied to this insect distinctively, as *the* caterpillar *par excellence*. The "army-worm" is a title which has often been applied to this insect, but is one which should be avoided on account of the danger of confounding it with the army-worm of the North.

In order to avoid this danger many have called it the "cotton army-worm." Mr. Glover has given his sanction to this name in the Department of Agriculture reports. It has also been called by many writers "the cotton-caterpillar," a name sufficiently distinctive. By many it is known by the simple term "the caterpillar" in contradistinction to "the worm" as commonly applied to the boll-worm. By others, and these are by far the majority, it is termed "the cotton-worm." This latter name we have adopted as being the shortest, simplest, and best adapted for a popular name. The moth has generally been called the "cotton-fly" or "cotton-moth" or "cotton-worm-moth."

As to the scientific name of this insect there is some doubt. The species was described in 1827 by Thomas Say as *Noctua xylina;* and it was long known under that name. In 1874 Mr. A. R. Grote discovered that an insect, which he believes to be our cotton-worm-moth, was figured and described by Hübner in 1822 under the name of *Aletia argillacea*. The latter name is the one which is now in general use.

PAST HISTORY.

The cotton-worm is probably indigenous to South America, and is an introduced insect in the United States. The first appearance of it in this country now on record was in 1793. This was followed by an extremely disastrous invasion in 1804. From 1804 to the present day there has never been a season in which the cotton-worm has not done more or less damage in some part of the cotton States. Among the years in which this insect has been most destructive were 1804, 1814, 1825, 1844, 1846, 1866, 1867, 1868, 1872, 1873, and 1876.

STATISTICS OF LOSSES.

The following table presents the estimated losses from the ravages of the cotton-caterpillar. The percentage estimates are taken from the answers of correspondents, and the actual loss readily obtained from the known average value of the crop:

States.	Percentages of loss for worst years.			Total crop.—Average for 14 years, in bales.	Losses.—Average for worst years, in bales.	Value at $50 per bale.
	Highest.	Lowest.	Average.			
South Carolina	....	....	5	224, 5[illegible]	11, 225	$560, 000
Georgia	25. 1	15	16. 5	474, 600	78, 422	3, 912, 000
Florida	....	....	24	49, 700	12, 000	600, 000
Alabama	25. 2	12. 5	17. 8	536, 700	95. 790	4, 789, 000
Mississippi	24	15	17	[illegible]	[illegible]	6. 150. 000
Louisiana	....	....	20	438, 700	89, 740	4, 487, 000
Texas	35	20	28	525, 000	148, 125	7, 406, 000
Arkansas	....	....	8	347, 000	27, 760	1, 380, 000
Tennessee	....	....	5	147, 000	8, 365	418, 000
Total	....	....	17. 2	3, 449, 200	594, 497	29, 711, 000

The terms "highest" and "lowest," in the columns devoted to percentage of loss, do not refer to the greatest amount of injury, or the reverse, inflicted in individual localities, but to a general average for the principal counties of heaviest production on the one hand, on the average for the remainder of the State on the other. The average for the State as a whole appears in the third column.

The result shows a possible loss of $30,000,000 in years of general prevalence of the worm, and as these visitations are becoming more frequent, it is probable that the real losses from the cotton-caterpillar are equivalent to an average of $15,000,000 to $20,000,000 annually for the entire period since the war. There is much evidence also to show that the losses were equally disastrous prior to 1861.

It should be stated that the Indian Territory, Virginia, and some other States, produce a small amount of cotton; which, with the productions of North Carolina, are not included in the above figures. It should also be borne in mind that while the quantities are assumed as State averages for the period since the war, they are approximately correct, sufficiently so for the purposes of this exposition.

Fifty dollars has been assumed as the price of a bale of cotton, though an average of fourteen years would raise these figures considerably. The plantation prices, from 1865 to 1870, ranged from 40 cents per pound down to 12 cents; or, per bale, from $180 to $60; and cotton is now sold upon the plantation at $10. Our estimate, therefore, of $50 per bale, is only an average for the last eight years.

Of course the percentage of loss cannot be demonstrated beyond possibility of cavil; the aim has been to make it too low, rather than a possible exaggeration.

HABITS AND NATURAL HISTORY.

THE EGG.—In this stage of its existence the cotton-worm is known to but few people, both its color and size shielding it from the observation of untrained eyes. Every cotton planter should, however, not only

become familiar with the appearance of the egg but know just where to look for it. With this knowledge time may be gained, the loss of which in the application of remedies may result disastrously. As it is now, the worms are rarely observed until nearly full-grown, and then but little time remains for the protection of the crop.

The egg is circular, much flattened, and ribbed; its greatest diameter is a little more than one-fortieth of an inch (.685^{mm}); its form is shown in Plate IX, Fig. 1. When first laid the egg is of a beautiful bluish-green color; this changes to a dirty white before it hatches.

Owing to the fact that the tender foliage at the top of the plant is first destroyed by the cotton-worm, it is generally believed by planters that the greater number, if not all, the eggs are laid upon that part of the plant. This belief gave rise to the practice which has been carried on in some localities, of cutting off and destroying the terminal shoots of the plant; the planters thinking that in this way the eggs would be destroyed and the crop saved. This idea I found to be an erroneous one. Rarely eggs may be found on any part of the plant above ground, but almost invariably they are deposited on the lower surface of the larger leaves, and by far the greater number of them are to be found on the middle third of the plant. (Plate VII, fig. 1.)

The eggs are deposited singly, and I rarely found more than four or five upon a single leaf, even when the moths were most abundant; still they sometimes occur in greater numbers. The duration of the insect in this state varies greatly, depending upon the season. During the warmer part of the summer months the eggs hatch in little more than two days after they are deposited, but in the autumn they may remain nearly a week before the larvae issue.

THE LARVA.—Some time before the larva issues, it can be seen through the transparent shell of the egg, the eyes, mandibles, and V-shaped suture separating the epicranium from the clypeus being especially prominent. A few hours later, after repeated efforts, which are plainly visible with a microscope, the larva succeeds in breaking a hole through one side of the shell, and it soon eats its way out. Occasionally the larva, as soon as it emerges, eats a portion of the egg-shell; usually, however, the shell is left undisturbed.

The newly-hatched larva is of a very pale-green color, or white with a faint tinge of green; the head is pale yellow, with no trace of the black piliferous spots which are so conspicuous in the later stages; the ocelli are black; the piliferous spots of the body are at first quite indistinct, but soon become more prominent; the thoracic legs and the third and fourth pairs of abdominal legs are very long; the first and second pairs of abdominal legs are mere tubercles.

The young larva usually remains on the lower surface of the leaf upon which the egg was deposited, feeding upon the more tender portions and leaving the upper cuticle unbroken. Sometimes, however, small larvae, which evidently have been hatched recently, are found on leaves where no signs of egg-shells can be detected, while shells but no larvae are found on larger leaves just below these. Yet I believe that the larvae always feed a little before leaving the leaf on which they were born. The young larva does not eat entirely through the leaf until it is nearly two days old, and often not until the fourth day after it leaves the egg. Thus the earliest indication of the presence of the worms is numerous, small, semi-transparent spots upon the larger leaves. The smallest larvae which I found eating through a leaf in the field measured from five-sixteenths to three-eighths inch in length (8^{mm} to 9.5^{mm}). In confinement the newly-hatched larvae eat the upper surface or lower surface

of the leaf according as they happen to be on one side or the other, but do not perforate the leaf till two to four days old. The injury done to the cotton during this early part of the life of the larvae is inconsiderable.

Observations made in the field during the month of August indicate that, as a rule, this insect lives at that season thirteen days as a larva, before webbing up, and remains as a larva one day after this, before changing to a pupa. Occasionally two days elapse between the webbing up and the change to pupa. Specimens which were kept in breeding-cages in my office remained eighteen days in the larval state. This unusually long time was probably due to the fact that the temperature of the room in which they were kept was much lower than that in the cotton-fields. Specimens bred by Professor Glover under similar circumstances passed twenty days before webbing up.*

The larva sheds its skin five times during the period of its growth. The individuals which I bred molted at regular intervals of three days, the first molt being made when the larvae were three days old. At this molt nearly all the larvae ate their shed skins. During the first stage the head of the larva is marked only by the six black eyes on either side. After the first molt the conspicuous black spots on the head appear. When six days old the larvae molted the second time, and when nine days old the third molt occurred. At this molt the larvae began to vary in color; some becoming striped with black and others remaining green. On the twelfth day the fourth molt occurred, and the fifth molt on the fifteenth day. Three days later the larvae webbed up. When full grown the larva measures one and five-eighths inches in length. A detailed description of the full-grown larva is appended to this section.

The variation in color referred to above is quite interesting; no explanation of it has been discovered. I found by experiment that the distinction is not a sexual one, as moths of each sex were bred from each kind of larvae. General observations, that is, those made without absolutely counting the individuals of each color, show that there are no dark larvae in either the first or second broods. About one-fourth, or less, of the third brood are striped with black. About one-half, or slightly more, of the fourth brood are dark, many of them being almost entirely black; while nearly all of the fifth brood, "third crop" of the planters, are black or very darkly striped.

After the larvae become large enough to eat through the leaves, or, in the language of the planter, "to rag the cotton," they move to the top of the plant and destroy the tender terminal foliage; thus the earliest indication usually observed of the presence of the worms is the "ragging" of the tops of the plants. As already stated, this has led to the practice of "topping" the cotton.

In feeding, the worms rest upon either the upper or lower surface of the leaf, but more frequently upon the latter. They eat most early in the morning and late in the evening. As we have frequently observed with other caterpillars, the cotton-worm may often be seen resting upon some portion of the plant, supporting itself by its prolegs and swinging the anterior part of its body from side to side as if fanning itself. The larva has another interesting habit. When touched or otherwise frightened, or sometimes when it wishes to move to another part of the plant, it suddenly throws itself by a jerking motion into the air. I have carefully studied this mode of jumping. It is as follows: The larva clings to its support by its three posterior pairs of prolegs; it swings the an-

* Agricultural Report, 1855, p. 75.

terior part of its body to one side, and then, rapidly moving it to the other, lets go at the proper moment; the momentum of the anterior part of the body is sufficient to carry the whole body some distance. In this way a larva can jump two feet in a horizontal direction. They will often spring from the highest part of the cotton plant and fall to the ground. On one occasion (August 26) I was in a field where the plants were nearly stripped of their leaves at the top; the larvae were moving to the lower leaves. I saw none crawling down the stalks. All, so far as observed, performed the journey by jumping. They rarely fail to alight upon their feet and cling to the object touched. Not one in fifty strikes one leaf and falls to another before getting hold with the hooks with which the prolegs are furnished. Many, springing too far from the plant, would touch no leaf and thus fall to the ground. I have been unable to find any silk connecting the larva with the object from which it springs; and I am of the opinion that in jumping it does not spin a thread.

I did not observe a single instance of *systematic* marching, as is indicated by the popular name army-worm, which has been so generally applied to this species. I saw on several occasions immense numbers of the larvae on the ground, crawling in *all directions* in search of food or places in which to transform. And on one occasion I saw myriads of the worms of different sizes crawling in all directions over the ground, when there was plenty of food and places in which to transform on the plants, as not more than one-third of the foliage had been eaten. This was the time when I observed so many larvae springing from the stripped upper portions of the plant to the leaves below; perhaps most of the worms on the ground were those which, in jumping, had failed to alight on the lower leaves. I visited the field at night to ascertain if the marching was kept up at that time. I found none crawling over the ground, and nearly all those on the plants were perfectly at rest.

When the larvae are feeding on the cotton in great numbers there arises a peculiar sweetish odor, which, although not easy to describe, is very characteristic. This odor, I supposed, proceeded from the excrement of the larvae; but Mr. Trelease is of the opinion that it is "due partially to the crushing of the leaves by so many mandibles." In any case this odor is perceptible only when the larvae are present in great numbers. The fact that many planters say that they can smell the worms sooner than they can find them otherwise is very strong evidence of the lack of proper knowledge of the habits of this species.

Although, as a rule, the cotton-worm feeds only on the leaves of the cotton plant, it is occasionally found lying within the open flowers feeding upon the stamens. It also frequently destroys the buds and small bolls. This is the case when the plant is stripped of its foliage. I have also seen many buds and bolls destroyed when the foliage on the lower third of the plants was eaten but little. When a cotton-worm destroys a boll, it does not, like the boll-worm, merely eat out its contents, but often eats the greater part of the pod also.

From what has been learned respecting the time required for the full development of the larva, and the small amount of injury done during its early stages, it can be seen that the accounts which are often heard respecting the short time which elapses from the first appearance of the worms to the complete destruction of the crop are founded on an error. We have heard many accounts of instances where fields had been attacked by cotton-worms and destroyed within three days! If by "first appearance" one understands the earliest time at which a brood of cotton-worms has been developed of sufficient size, both as to individuals and numbers, to be easily seen, these accounts will not convey

wrong impression. For example, a planter informed the writer, in reply to questions respecting a certain field, that the worms first appeared in it three days previous. It was a field adjoining his residence, through which he passed every day, and was one to which, as he informed me, he had paid special attention. On visiting the field I found it very badly infested with cotton-worms which were then *two-thirds grown*, and hence must have been much more than three days old.

Although observers may fall into error respecting the time required for the devastation of a field of cotton by this pest, exaggeration is hardly possible respecting the completeness of the destruction which sometimes occurs. We have repeatedly seen places in which the plants were so completely stripped of their foliage that there were not left as many uneaten leaves as there were stalks, a few dried and brown leaves on the lower part of the plants being the only semblance of foliage left on what, ten days previous, was a beautiful green field. In cases of this kind, not only are all the green leaves eaten, but the young bolls are also destroyed, and often the bark is gnawed from the small branches.

The stopping of the growth of the plant is not the only loss which the destruction of the foliage entails. Open cotton is frequently injured by the dropping of the excrement of the larvae upon it. Much injury also results from the premature opening of the bolls, caused by the destruction of the foliage. Not only is such cotton of inferior quality, but when, in addition to the fully-developed bolls, many immature ones are made to open, it is often impossible for the planters to pick the cotton before much of it falls out upon the ground and is thus seriously damaged. Immense losses sometimes occur in this way, when wind and rain closely follow the destruction of the foliage by the worms.

On the other hand, in some parts of the cotton belt—notably the more northern sections—the advent of the cotton-worm is not dreaded. It rarely reaches these regions till late in the season, and then the planters consider the destruction of the foliage a benefit rather than otherwise, as in this way the maturity of young bolls, which would otherwise be destroyed by frost, is hastened. Sometimes, even in southern portions of the cotton belt, in localities where the plant grows very rank if the worms do not appear early, the destruction of the leaves late in the season is regarded as a source of profit.

No well authenticated instance is recorded of the cotton-worm feeding upon any plant except cotton.* Many experiments were tried to induce them to feed upon other plants, all resulting negatively. Even when the larvae were placed upon plants closely allied to cotton they starved. Still there is reason to believe, as will be shown later, that another food-plant exists in Wisconsin at least.

When full grown, the larva folds one edge of a leaf over its body and fastens it down with yellowish silk. (Plate VII, fig. 7.) It then spins a delicate cocoon about itself. At times, when the cotton-worms are very numerous, it frequently occurs that the foliage is so badly eaten that it is with difficulty that the worms find a leaf in which to web up. Their endeavors to conceal their bodies before pupating are at such times very amusing. The merest fragment of a leaf is called into service; and frequently very vigorous struggles ensue between rivals endeavoring to secure the same place. Often, too, the trouble of the successful competitor does not end with his webbing up. Other larvae not yet

*P. Winfree, De Bow's Review, iv, 251 (1847), says: "In the West Indies they feed promiscuously on the leaves of a plant there called the salve-bush; this plant grows about the height, and its leaves are a good deal like the mullein of this country, having a whitish color and a soft velvety feeling.

fully grown, finding this remnant of a leaf, devour it, exposing the pupa, which either falls to the ground or hangs suspended by some of the silken fiber which happens to be attached to the uneaten frame-work of the leaf. A detailed description of the larvae is appended. This will serve to distinguish the cotton-worm from other larvae which are sometimes mistaken for it.

ALETIA ARGILLACEA, Hübner.

Full-grown larva.

Length, 1⅝ inches (41^{mm}). Color, light-green, striped with white and black, and spotted with black and yellow; in many individuals, especially those of the earlier broods, the black stripes are wanting. Head, ochre-yellow, with thirty black spots, from each of which arises a short, stiff, black hair (13 *a*). Body, light-green, with dorsal line, two subdorsal lines, and lateral line white, and with numerous intensely black piliferous spots. The more conspicuous of these spots are arranged as follows: Eight forming two transverse rows of four each on the dorsal part of the first body segment (prothorax); a simple transverse row of four on each of the two following segments (in these two rows the inner spots are much smaller than the outer ones); on each of the eight following segments (first to eighth abdominal), four spots, forming the angles of a square; a row of spots on the lower subdorsal line, one spot on each segment; below these, three spots, forming a triangle. In the green varieties, the piliferous spots are surrounded with white, and are thus rendered more conspicuous; spiracles black. Usually a row of indistinct yellow spots upon and above the upper subdorsal line. All legs pale-green; claws of thoracic legs black; first pair of abdominal legs rudimentary; second pair half as large as third pair. The distribution of black varies greatly in different specimens. In some there are no black stripes, this color being almost entirely absent, except in the piliferous spots described above; in other specimens all that part of the body above the lateral line, excepting the dorsal and subdorsal lines, is black. The following grades between these two extremes may be found:

a. Dorsal line bordered on each side with black; varies in width in different specimens, from those in which it is a mere line to those in which the entire space between the dorsal line and the upper subdorsal line is black.

b. Similar to variety *a*, except that the space between the subdorsal lines is also black.

c. Similar to variety *b*, except that the space between the lateral line and the lower subdorsal line is more or less black. Antennae three jointed, basal joint large, fleshy; second joint about one-third the length of first joint, and often not visible, being withdrawn into first joint; third joint equal in length to the first and of a brown color. This joint bears at its outer extremity three conical tubercles one of which is large, appearing like a subjoint, and bearing a small tubercle; mandibles strong, pale, with their edges and teeth black; teeth, four, rather dull.

THE PUPA.—After the larva has formed its cocoon within a folded leaf, its body shortens and increases in diameter, assuming a somewhat fusiform shape. Those parts that were light green become bluish or copper color. After one or two days have elapsed the larva sheds its skin and becomes a pupa.

This is at first of a delicate green color, but in a few hours it changes to a chestnut-brown, which sometimes becomes so dark as to be almost black. This change in color is attended by a toughening and hardening of the body walls. Frequently the head, thorax, and wing-sheaths become darker than the remaining portions of the body. The posterior third of the fourth, fifth, and sixth abdominal segments is much lighter in color than the remaining part of the segments. When the pupa is much contracted, the lighter portion of each of these segments is covered by the following segment: The length of the pupa varies from five-eighths to thirteen-sixteenths inches (16^{mm}–20^{mm}). Its form is shown on Plate VII, Fig. 10. The wing-sheaths nearly reach the fifth abdominal segment.. The tip of the abdomen is furnished with four hooks. A short distance in front there are four other hooks, each one rising from a small pit. Plate IX, fig. 2, represents two views of this part of the pupa, *a* the dorsal view, and *b* the ventral view.

When a field is badly infested with cotton-worms they frequently eat the folded leaves containing pupae (Plate VII, figs. 8 and 9). Occasionally such pupae remain suspended by their hooks and fragments of the cocoon attached to the remains of the leaf (Plate VII, fig. 10).

The duration of the pupa state varies greatly. During the warmer part of the summer it is only six or seven days, but in the autumn individuals of this species have been known to remain a month in this state.

THE ADULT.—The size and appearance of the adult are represented on Plate VII, figs. 11, 12, 13. The general color of the upper surface of the wings and body is light brown. The anterior wings are tinged with wine-color on the inner and middle parts, shading into a light olive-green on the external portions. These wings are marked by several wavy transverse lines of a reddish color, and by a black or grayish spot near the center of each wing; outer border fringed with white, with six reddish spots. These characters will serve to distinguish this insect, but a more detailed description is appended to this section.

Unlike the larva, the adult *Aletia argillacea* is not confined to a single article of food, the moths feeding upon sweets of many kinds. Although nectar forms a considerable part of this food, the moths seldom visit flowers for this substance. A few plants possess nectar glands in addition to those of the flowers, and it is from such plants that these moths obtain nectar. The cotton plant is one of this number, each leaf being furnished with from one to three nectar-secreting glands. Usually there is but one of these, which is situated on the lower surface of the main rib, near the petiole (Plate VII, fig. 14); occasionally leaves can be found in which each of the three larger ribs is furnished with a gland. This gland appears to the naked eye as a swelling of the rib, in the center of which is a depression containing usually a drop of clear, somewhat viscid, sweet fluid. When this fluid is not consumed by moths, ants, or other insects it will accumulate so as to form a large drop projecting beyond the walls of the gland. Other glands, similar in appearance and function, are situated, one at the base of each of the three bracts forming the involucre or "square," and sometimes also three additional glands at the bottom of the calyx alternating with these bracts.

While in the field, during the summer of 1878, I became interested in these facts, which I afterwards learned had been observed long before by Professor Glover. When I informed Professor Riley of certain observations that I had made, he suggested that perhaps the cotton-moth also derived nourishment from these glands. Subsequently, at Baconton, we, in company with Professor Willet, went into the field at night with dark-lanterns to study this subject. Within a half hour from the time we entered the field, I had the pleasure of pointing out to Professor Riley a moth in the act of sipping nectar from a gland at the base of a boll; thus proving the truth of his inference. We also observed moths feeding at the heads of *Paspalum læve*, a common grass growing as a weed in the cotton fields. Although no other moths were observed at that time to feed on the nectar of cotton, during the present season (1879) many observations have been made showing that it is the normal habit of this insect to do so. A few days after the discovery of the moth feeding at the extra-floral nectar glands of the cotton, my host, Captain Bacon, informed me that as he was riding home in the evening from a distant part of his plantation he observed a large number of moths flying about some cow pea vines that were growing in a corn-field. I at once equipped myself with a lantern and proceeded to the corn-field. On arriving there I witnessed a remarkable sight; thousands of the cotton-moths were about the pea-vines feeding on the nectar excreted by a

series of glands situated near the end of the peduncle which is produced beyond the last flower or pod. The moths were not at all shy, but would remain engrossed in partaking of their repast even when the lantern was brought within a few inches of them. In no instance were the moths seen to visit the flower of the pea.

It is probable that the cotton-moth feeds upon nectar excreted by many other plants. Mr. Trelease observed it feeding at the ovate glands which are situated at the base of the petiole of the larger coffee weed (*Cassia occidentalis*), at the glands on the flower stalks of the cow-pea, and he frequently noticed that when the moths were numerous they collected among sweet-potato vines, where they appear to have been attracted by the nectar secreted by two small glands on the petiole of each leaf, near the insertion of the blade.

The subject of extra floral nectar glands is very interesting; and it is one which has been studied but little. The problems presented by it are quite puzzling. In the case of the nectar glands of flowers we have organs which, serving to attract bees and other insects, and thus insuring cross-fertilization, are very useful to the plant. But the functions which extra floral nectar glands perform are seldom as obvious. In case of the cotton plant these glands serve to attract the moths and thus insure the oviposition of eggs upon it. Thus the plant upon which the glands are the most active will prove most attractive to the moths, and hence will be the one the most likely to be infested by worms. Therefore, instead of being beneficial, as we know the floral nectar glands to be, the extra floral glands seem at first sight to be injurious to the plant.

It was not until we learned that the small ants, so abundant in cotton fields and which are attracted to the plants by these glands, are the most efficient check upon the increase of cotton-worms that we understood how beneficial these glands really are. For, although the moths, led by instinct to oviposit only upon the food plant of their young, would visit the cotton plants even if the glands were not present, it is not improbable that the ants are first attracted to the plants by the supply of nectar which they find there, and as this nectar is secreted by the very young plants the ants doubtless begin the destruction of cotton-worms as soon as they appear. The statement of Professor Riley that "these sweets are first produced when the plant begins to flower and fruit" (Annual Report Department of Agriculture, 1878, p. 215), was merely a conjecture which subsequent observations failed to confirm. In reality, glands were found on some cotyledons; these, however, did not seem to secrete nectar; but the gland on the first leaf begins to secrete nectar (as indicated by the first visits of ants) about the time that the third or fourth leaf expands.*

The cotton-moth is not confined to a diet of nectar, as many fruit-growers have learned to their cost. Frequently the fig crop is completely destroyed in some sections of the cotton belt, as is also the August crop of peaches. The moths have also been known to feed on apples, grapes, melons, and the jujube. A remarkable instance of their feeding on melons in Wisconsin was communicated to Professor Riley last year by Dr. P. R. Hoy, of Racine, Wis.

Recently, at my request, Dr. Hoy sent to this department a specimen of a melon-eating moth, and it proves to be without doubt *Aletia argillacea*. Dr. Hoy's observations are very interesting, not merely as illustrating another mode in which this pernicious pest may be the source of

*The bearing of this subject of nectar upon the subject of the enemies of the cotton plant is so important that we requested Mr. Trelease to prepare a paper upon it, which will be found in the special report.

serious annoyance, but also as bearing on the question of the migratory powers of the moth. We shall have occasion to refer to this again.

Although it appears from the letter of Dr. Hoy that the moths injured only those melons which were cracked, it is certain that in the case of figs, peaches, and grapes the moths have the power of piercing holes through the unbroken rind of the fruit, and thus of destroying fruit previously uninjured. That a moth should have this power is a remarkable fact. As a rule, butterflies and moths are only able to sip fluid sweets from open reservoirs, as the nectaries of flowers, the organ with which this is done being soft and flexible.

While in the field last year I carefully watched the operation of piercing the skin of a peach. At times the moth used the tip of its maxillae as if it were trying to prick a hole into the fruit; at other times the tip of the maxillae was incurved, and the dorsal surface thus presented to the peach used as a rasp. A study of the structure of the maxillae shows how well adapted they are for piercing and rasping. The tip of the organ is well adapted for piercing, as is shown by Plate IX, Fig. 3; and the portion immediately preceding the tip is equally well adapted for rasping, being furnished with numerous spines on the dorsal surface. The ventral surface of this part of the organ is also provided with spines. Probably these are of little use in piercing the rind of fruit, but doubtless they aid much in enlarging a hole when it is once made, and also in lacerating the pulp of fruit, thus setting free the juice. Plate IX, Fig. 4 represents a cross-section of the maxillae. The relation of all the parts is well shown, excepting the arrangement of the muscles which are within the walls of each maxilla. These muscles were torn in cutting the section.*

There has been some discussion respecting the natural position of the moth while at rest. I found that in the field it almost invariably alights with its head down, but the majority of specimens which I saw in houses, when resting on the walls, did so with the head directed upwards.

During the warmer part of the season the moths in confinement began to oviposit within thirty-six hours after emerging from the pupa state. During the autumn the time varied from four days to a week. The greater number of eggs are laid during the night. As already stated, the eggs are deposited chiefly on the lower surface of the larger leaves on the middle third of the plant. This may be owing to the fact that the moth is attracted to that part of the plant by the nectar glands which are on the leaves. In fact, Mr. Trelease observed moths alternately sipping nectar from these glands and ovipositing. During the operation the moths flew from leaf to leaf and from plant to plant, each moth depositing but a single egg on a leaf. Still, if we accept this as explaining why the moths oviposit on that part of the plant, it is difficult to say why more eggs are not laid near the glands on the involucre, which the moths also frequently visit.

The number of eggs laid by a single moth probably varies from 400 to 600. September 11, I counted the number of eggs in the ovaries of a female taken in the field. There were 400 well-developed eggs and

*As this report is written chiefly for those who have not made a special study of entomology, a few words in explanation of the structure of the maxillae of moths will not be out of place. In their simplest form, the mouth parts of insects consist of an upper lip, an under lip, and two pairs of jaws acting horizontally between them. In the case of butterflies and moths (*Lepidoptera*) the lower pair of jaws (the maxillae) is developed into two long, flexible organs; each of these has on one side a groove, and the two are fastened together so that the grooves form a tube, as shown in the center of Fig. 4, Pl. IX.

234 immature ones. After that date I dissected many females, but found only immature eggs.

It is difficult to say how long this insect exists in the adult state; doubtless the time varies greatly with the season. Moths of the third and fourth broods die in confinement within five days after their exclusion from the pupa, while, as we shall show later, those of the last brood remain alive several months.

The number of broods of this insect in a single season is also somewhat difficult to determine. For not only does the earliest brood appear at different times in different sections of the cotton belt, but in the same locality different individuals of the first brood were found to vary in age nearly two weeks. As a result of this variation during the latter part of the season, examples of all stages were found at the same time in the same field. Still a large proportion of the cotton-worms in a given locality undergo their transformations at nearly the same time; so that broods sufficiently well marked for our purpose have been observed. And we conclude that in those sections in which we believe the moth to hibernate, there are each year at least six broods. By the 1st of September of the present year (1879) larvae of the fifth brood (third crop) were appearing in considerable numbers in Central Alabama. Moths bred from specimens of this brood which were sent to this department began to oviposit October 10, and October 15 larvae of the sixth brood began to appear. It is probable that the sixth brood appeared at an earlier date in Alabama, the development of the specimens in my breeding-cages being retarded by the low temperature of the room in which they were kept.

One of the most remarkable things in the natural history of this insect is the power of flight which the moth possesses. There is no reason to believe that the species can survive the winter north of the cotton belt; still, the moths have been repeatedly taken far north of the limit of cotton culture; we are, therefore, forced to conclude that these moths have flown, aided perhaps by winds, from some portion of the cotton belt to where they were found; or that they are the descendents of such moths. Dr. Packard has taken the moth on Coney Island and in Salem Harbor. Mr. Edward Burgess states that it flew aboard his yacht in Boston Bay, September 9, 1873. Mr. Grote informs me that it has occurred at Buffalo in September and October, and that he has heard of it at Chicago, Detroit, London, Ont., Albany, and New York. Professor Riley reports it from Chicago. The letter of Mr. P. R. Hoy, already quoted, shows that it has occurred at Racine, Wis, in the autumn, repeatedly, in great numbers. And one unbattered specimen was taken at Ithaca, N. Y., in the fall of 1879. It will be noted that, in all the instances in which the date of the occurrence of the moths in these northern localities is given, they were found only in the autumn. This confirms the conclusion that the moths cannot endure a northern winter, and that their presence in the Northern States is dependent on migrations from the South.

That the moths found in the North may be, in some instances, simply the descendants of moths that have migrated from the South, and that this species has a Northern food-plant, is indicated by the fact that many of the specimens taken were in a fresh condition when found. I was led by this fact to endeavor to ascertain if the larva had ever been found in the North. As Dr. Hoy informed me that he had repeatedly found the moth while the wings were yet soft, not quite dry, I felt sure that the larva could be found near Racine if anywhere in the Northern States. I therefore sent Dr. Hoy specimens to compare with the different larvae

in his collection, and was rewarded by receiving from him a specimen which was undoubtedly the larva of *Aletia argillacea*. Respecting it Dr. Hoy said:

> I send to-day the only Wisconsin larva of the *Aletia*. I only secured five, one of which I preserved; the other four died in my breeding-cage, as I did not know what they were, and was deceived as to the plant on which they were found. This is my record: "Taken in Pike Woods by Mary Dell, August 10, 1870; food-plant not satisfactorily described; unknown to me."

A detailed description of the adult is appended.

ALETIA ARGILLACEA, Hübner.

♂ ♀.—Color above light brown tinged with olive-green and wine color. Expanse of wings one and three-sixteenths inches to one and seven-sixteenths inches (30mm to 36mm). Length of body three-sixteenths to eleven-sixteenths inches (15mm to 17mm). Head varies from light brown to wine color, with a small whitish tuft before. Antennae clothed with dark-wine colored and white scales above, and short yellow hairs below. Mandibles conic, light yellow, furnished at the tip with a brush of spiny hairs. Labial palpi densely clothed with short scales which are white and wine color mixed; second joint twice the length of the first; third joint equaling the first in length but much smaller. Thorax same color as head. Anterior wings tinged with wine color on the inner and middle part, shading into a light olive-green on the external portion. In some specimens the anterior wings are light olive-green throughout; in other specimens the reddish tinge is very pronounced.

External to and in front of the central portion of the anterior wing is a conspicuous black or grayish spot, composed of dark scales interspersed with white ones. Parallel to the anterior margin of the wing is a row of four minute white spots; one is situated at the base of the wing, one between the dark discal spot and the anterior margin of the wing, the other two at equal distances between these; one or more of these spots are frequently wanting, and sometimes each one is surrounded by reddish scales; the anterior wing is also marked by three transverse wavy lines, of a reddish color margined with white: the inner line is one-fourth of the length of the wing from the body, the second line is near the middle of the wing, and the third line is outside the discal spot. Fringe white with six reddish spots: posterior wings with basal portion light, and outer part clouded: lower surface light brownish gray; anterior wings with disk clouded and a short reddish band on the outer third of costa; posterior wings with a transverse, narrow, wavy, brown band near the middle of the wing. Described from 75 specimens.

THE THREE CROPS OF WORMS.—Notwithstanding that there are probably five or six broods of cotton-worms every year in the southern and central parts of the cotton belt, it is generally believed that there are only three broods. These have been designated by the planters as the first, second, and third crops respectively. It is impossible to state a rule by which it can be determined to what broods the three crops correspond, as this differs in different localities and different seasons. Almost invariably the first brood of worms, and very often the second, also, are so small that they escape the notice of observers. After a brood of sufficient size to be easily perceived has been developed, in about two more generations a sufficient number of worms is produced to strip the cotton of its foliage. The result of this, as will be shown later, is the destruction of the greater part of the worms also. The subsequent broods are small; on this account, and because of the cotton crop being destroyed, the planters lose interest in the development of the worms, and the later broods are not noticed. In a word, the idea of there being only three "crops" of worms has arisen from the fact that as a rule there are only three broods of sufficient size to be noticed by the planters before the cotton crop is destroyed, or before the cotton has reached a stage of maturity, after which the eating of the foliage by the worms is not considered a calamity. In some instances the first crop of worms is doubtless the second brood of the season; in some instances it is not until the third brood is produced that the worms are of sufficient numbers to be observed, and thus designated as a crop.

The term "crop of worms" has become thoroughly incorporated in the language of those most interested in the cotton-worm; and, moreover, it is a very convenient term. We shall therefore adopt it; employing it, however, in the sense in which it is generally used. Thus, by first crop of worms we shall mean not the first brood, but the earliest brood that is of sufficient size to be easily noticed, and the second and third crops are the two broods immediately following the first crop. The term brood will be used in its usual sense.

Disappearance of third crop.—While contemplating, in the autumn of 1878, the immense number of worms which constitute the third crop, I was struck with the fact that if even a thousandth part of them were to mature and survive the winter the second brood in the spring would be of sufficient numbers to destroy all the cotton. I was therefore interested in watching the disappearance of this so-called third crop.

The result of these observations shows that when the cotton-worms occur in sufficiently great numbers to strip the cotton of its foliage the greater part of that brood perishes at once.

When the leaves of the cotton are destroyed the worms are forced to migrate in search of more food, or, if they are fully grown, as is often the case, in search of places in which to undergo their transformations. While at Faunsdale, Marengo County, Alabama, August 28, 1878, I was fortunate enough to witness an attempted migration of this kind, which was attended with astonishing results.

As soon as the larvae left the cotton stalks they experienced great difficulty in crawling over the surface of the ground. Clinging hold of the loose particles of earth by its prolegs, a larva would attempt to stretch its body forward in the manner peculiar to "loopers," but no sooner was the anterior part of its body raised from the ground than the insect, unable to balance itself upon the crumbling bits of earth, would fall to one side with the full length of its body upon the ground. Had it been a cloudy day, or had the ground been shaded, this would not have been so serious a matter to the larva; but, as is usually the case at that season of the year, the sun was shining with an intense heat and the surface of the soil was as hot as the sides of an oven. The larvae did not seem to suffer so long as they were resting with their legs upon the ground, but no sooner did one of them fall so as to touch the earth with its body than it began to squirm violently. Sometimes a larva would regain its position upon its legs, but the first attempt at looping would result as before, and in a very short time, often not more than one or two minutes, it would succumb. The number of worms destroyed in this way is immense. I am certain that in the field in which I made these observations there were to each square foot of land at least an average of five dead worms that had been killed in the way described within a few hours. Other causes tend to render this destruction more complete. Thousands of larvae are destroyed by ants. Many pupae and larvae which have "webbed up" and partially transformed are deprived of their covering of leaves by their voracious companions and fall to the ground, where they perish. And still others, apparently more fortunate in transforming within the folds of the leaves of other plants than cotton, are imprisoned in their retreats by their companions which follow and attempt to use the same leaves for the same purpose.

Disappearance of the last brood.—Evidently after the disappearance of the brood of worms known as the third crop, one or more broods are usually developed in some parts of the cotton belt. Wherever the earliest spring brood is of considerable size, there will be developed

in the second generation a sufficient number of worms to attract general attention. In this case the fourth brood will constitute the third crop, and there will remain sufficient time for the development of one or two later broods. As already explained, these broods are small and attract little attention. Nevertheless, the disappearance of the last brood is one of the most important points in the life-history of the cotton-worm. It is here that we may hope to learn much on the long-disputed point as to whether the species dies out each year in the United States or not. I regret that I have not been able to make personal observations on this point, as my stay in the field extended only to the first of October. Fortunately, careful notes bearing on this subject were taken by Prof. E. A. Smith, at Tuscaloosa, Ala., and by Prof. I. E. Willet, at Macon, Ga.

From these notes and from other material given in the special report, we feel warranted in stating the following conclusions respecting the disappearance of the last brood of worms: In making preparations to undergo their transformations, individuals of this brood do not differ in habits from those of the preceding broods, except that, as the foliage of the cotton is frequently destroyed, it becomes necessary for the worms to seek other places in which to web up. Thus we see the worms webbing up, not only in the leaves of cotton, but in the leaves of any plant that they can find, and even in the crevices of bark of trees. No tendency on the part of the worms to make a denser cocoon than those of the preceding broods was observed. A large part of the pupae, which were enveloped in leaves of cotton, became exposed and fell to the ground owing to the consuming of the leaves by other larvae. Many such pupae would naturally fall prey to predaceous insects or be destroyed by other causes. Thus we find, as with the third crop, that a large proportion of this brood is destroyed in a very short time after assuming the pupa state. The length of time which individuals of this brood remained in the pupa state varied greatly: many moths emerged early in October, and a few emerged each day till the latter part of the month, when heavy frost occurred. The only instances of moths emerging from the pupae state after a heavy frost, of which we have been able to learn, are those mentioned in Professor Smith's letters of October 26 and November 4, and in Professor Willet's letter of December 11.* Professor Smith also wrote, December 30: "All the chrysalides which I have examined are dead, so that not many, if any, will survive the winter."

FIRST APPEARANCE.—No point in the life-history of the cotton-worm is of higher interest than the first appearance of the insect in the spring. Not only may we expect to learn here important facts bearing upon the question of hibernation of the species in our territory, but other facts which will be of service to us in our efforts to devise some way in which to check the increase of this pest as soon as it appears. The general impression has been that the earliest appearance of the worms in the cotton fields was during the latter part of June or in July. This has been urged as a proof of the theory that the species dies out each season in the United States, and, what is much more serious, this idea has influenced the planters to neglect making any efforts to destroy the worms early in the season.

Although vigorous efforts were made to collect specimens of the moth early in the spring, none were observed. Baits of various sweetened mixtures were exposed: these attracted many moths, but none of them were *Aletia*. Neither did any specimens of the cotton-moth

* See special report.

come to light at that season. This, however, only proves the futility of any attempts of this kind to destroy the moth at that season of the year, for we know that moths were present and ovipositing on the cotton very soon after the young plants emerged from the ground. This is shown by the fact that May 21 a full-grown larva was found in Dallas County, Alabama, on some small cotton, which was planted April 30 and was well up about May 8. On May 23 another larva was found in the same field. As this cotton was immediately adjoining some which was planted a month earlier, there is a possibility that the larvae were hatched on the latter, and migrated to the place where found; but in any case it is evident that moths were flying and ovipositing on the cotton while it was yet quite young. Other larvae were observed at this time; one May 23 on the older cotton, and another June 3. These particular instances are cited, as there is no doubt of the identity of the larvae. We believe, however, that they were found even earlier in the season. Colonel Lewis, of Vernon Station, in the Canebrake region, Alabama, found a full-grown larva May 17; and May 24 they were reported from two other plantations in the Canebrake.

Thus we see that there is not as long an interval between the disappearance of the last brood in the fall and the appearance of the first brood in the spring as was supposed. In fact the interval is as short as possible; for the moths oviposit on the cotton as soon as there is sufficient food for the larvae. The first larva found by Mr. Trelease this season had consumed several plants.

A topic of scarcely less interest than the date at which the cotton-worms first appear is the localities in which the first brood occurs. Every planter with whom we have conversed on the subject informs us that in each locality the worms first appear on a certain plantation, and on a very limited part of that plantation. We examined several of these places carefully, but found no striking local peculiarities. They all agree, however, in being on low land and where the cotton has a thrifty growth. In connection with this testimony of the planters, we must take into account the fact that they seldom observe the worms till the latter part of June or even till July. It is evident, therefore, that it is the first "crop" of worms that appear in the above described localities, and that the testimony has but little bearing on the origin of the first brood. As yet we have but little data upon this point; but that which we have indicates that the first brood of worms is scattered indiscriminately over those sections in which they occur. Specimens of the first brood were found by Mr. Trelease on cotton growing on bottom land, in a swamp, on an elevation rising from this, and on a ridge considerably distant from the swamp. Thus no local peculiarities of the soil seem to influence the distribution of the worms, except that where the cotton is the earliest the moths first find a place to oviposit.

We have, therefore, a very interesting problem presented to us. Why is it that if individuals of the first brood of worms occur indiscriminately on cotton growing on wet and on dry land, that the greater proportion of the second or third brood (the first crop) is found only on low, wet lands? The only explanation we can offer, so far, is that in the wet lands there is but little to check the natural increase of the species; while in dry lands the predaceous insects, especially ants, destroy a large proportion of the larvae of the earlier broods. This point will be referred to again under the head of "influence of weather."

It has often been asserted, especially by those who advocate the theory of immigration of the moth, that the cotton-worm appears first in the western and southern portions of the cotton belt, and progresses regu-

larly toward the east and north. But this does not seem to be the case. As we have already shown, in the spring of the present year (1879) the worms were in Central Alabama as early as there was food for them. And in 1873, when the first brood was so large as to attract general attention, the worms appeared simultaneously (during May) in Jackson County and Gadsden County, Florida; Decatur County, Georgia; Marion County, Mississippi; and Atascosa County and Victoria County, Texas.

HIBERNATION.—How does the cotton-worm pass the winter? This is a question most often asked respecting this insect, and it is only recently that an answer could be given.

It has been contended by some that if the cotton-worm survived the winter in the United States, it would exist in such numbers in the spring that it would sweep away the young cotton plants at once. But, from what we have seen of the disappearance of the "third crop" and of the last brood, it is evident that in any case only a few individuals survive the autumn. Many have believed that the pupae of the last brood pass the winter in the ground. This we now know cannot be the case, as the larvae of the last brood web up in leaves in a similar way as do the larvae of other broods, and those pupae which fall to the ground on account of the destruction of their leafy covering are soon destroyed by ants. Even if they were not destroyed, they have no power of working their way into the earth, as has been supposed by many. Of the very many pupae which have been found in the ground and sent to this department by persons supposing them to be those of the cotton-worm, not one has proved to be such. Many moths closely related to the cotton-worm—that is, belonging to the same family (the *Noctuidae*)—pass the winter in the ground in the pupa state. It is such pupae, and especially those of the boll-worm, that have been mistaken for those of the cotton-worm.

The pupa of *Aletia* is represented on Plate VII, fig. 10, and that of the boll-worm on Plate VIII, fig. 9. But the most striking difference between the pupae of these two insects is exhibited by the form of the spines at the posterior end of the body. In *Aletia* the spines are eight in number, and are hooked as shown in the enlarged figure (Plate IX, Fig. 2). The pupa of the boll-worm has but two spines, and these are straight (Plate XVI, fig. 6). By observing this point it is easy to distinguish the pupa of *Aletia* from that of the boll-worm; and as soon as this is generally known we will hear less frequently of the former being plowed up. In fact there is now no reason for believing that the cotton-worm ever enters the ground to undergo its transformations; or that it ever passes the winter in the pupa state. Numerous instances of pupae, which were undoubtedly those of the cotton-worm, remaining alive after heavy frosts, and even till midwinter, are on record: but it is a suggestive fact that there are but few well-authenticated instances of pupae producing moths after heavy frosts have occurred, those mentioned in the letters of Professors Smith and Willet, referred to above, being the only ones known to us. Is it not probable that observers have been misled by the movements of pupae containing parasites? Every entomologist knows that dead pupae are frequently seen to roll about as if alive, the motions being due to the parasite within; and several instances have come to our notice where pupae of *Aletia*, that were supposed to be alive in midwinter, have proved to be parasitized.

Many planters believe that they have seen the adult during winter and early spring. But in nearly every instance when such moths have been sent to an entomologist they have proved to belong to some other species

than *Aletia argillacea*. Many moths have been sent to this department by persons supposing them to be the cotton-moth; but in every instance, with one possible exception, they proved to belong to other species.

During the winter of 1878–'79 the following named local observers for this department were on the lookout for living pupae or adults of *A. argillacea*: Professor Willet, at Macon, Ga.; Professor Smith, at Tuscaloosa, Ala.; Dr. Anderson, at Kirkwood, Miss., and Judge Jones, at Virginia Point, Tex. Not one of these gentlemen was successful. Professor Smith, in particular, made great exertions to obtain specimens of the adult. He had sweetened mixtures for attracting moths exposed during the entire winter; but although he constantly obtained other moths, as already stated, not a single *Aletia* was found. It is important to note that Professor Smith's observations were made at a point which may be farther north than the cotton-moth can hibernate. But in the latter part of December Professor Willet made a trip to Southern Georgia, where a careful search was rewarded only by a few dead pupae and many empty pupa-skins; the latter were found in dead wood and under bark of pine trees; many were also taken from ragweed on edge of a cotton field.

In addition to the efforts of the local observers, Mr. Schwarz, who has had a wide and very successful experience as a field entomologist, made an extended tour through the cotton belt in order to ascertain what he could respecting the winter quarters of this insect. Mr. Schwarz was no more successful in this particular than were his colaborers. A detailed account of his trip is given in the special report.

In considering the results of Mr. Schwarz's observations, it should be remembered that during the greater part of the time while he was in the field the weather was unusually cold, so that hibernating insects would not be likely to be out from their places of concealment; and that, as Mr. Schwarz has well said, the failure to find the hiding place of the cotton-moth is not proof that the species does not hibernate, for he also failed to find in their winter quarters other insects which are very common, and respecting the hibernation of which there is no doubt.

Although we firmly believe (both from the *a posteriori* reasons, which were given at length in the special report, and from positive evidence to be soon brought forward) that the cotton-moth hibernates in some portions of the cotton belt of the United States, we have given these negative results at length, not merely for their purely scientific interest, but as furnishing valuable data to be used in making plans for the destruction of this pest. For they show conclusively the impracticability of attempting to destroy the insect in its winter quarters.

The undoubted positive evidence of the hibernation of this insect consists of a very limited number of observations; for although we believe that at least few of the many planters who think they have observed the cotton-moth in midwinter and early spring are right, still the fact that in every instance but one,* when specimens of the moths observed have been sent to entomologists, it has been found that some other species has been mistaken for *Aletia argillacea*, prevents our accepting testimony of this kind.

But we cannot doubt the statements of so accurate an observer as Mr. Thomas Affleck, who says, in his Southern Rural Almanac, 1851, pp. 49, 50:

On the 22d of December last, 1849, I saw great numbers of the *cotton-moth* during the dusk of the evening flitting about the fence-corners, dead trees which still retained

*Prof. C. V. Riley has received two female cotton-moths from James F. Bailey, of Marion, Ala. These moths were taken on the night of the 12th of February, 1880. They were taken from a mock-orange tree (*Cerasus caroliniensis*) then in bloom.—[*American Entomologist*, March, 1880.

their bark, and about certain sheds near this village—Washington, Miss. The weather was and had been unseasonably warm. A few cool days followed, during which I could not find a single moth. But again, on the 27th or 28th of the same month, I saw them in equal numbers. I leave it to naturalists to say whether or no this settles the question of hibernation. It is positive evidence, so far as it goes. Whether they continued to exist until the cotton plant was large enough to support their progeny I cannot say; nor could I satisfy myself as to where they found shelter.

Equally interesting are the observations of Mr. John P. Humphreys, late naturalist and entomologist to the State department of agriculture of Georgia, who says in a letter which we recently received from him:

1st. *That it hibernates in the chrysalis state.*—This may be true of other "cut-worms" (which in some cases I doubt, while in others I know), but there is not the slightest warrant for any such supposition in the history of *A. argillacea*, Hübn. This question I have subjected to the most crucial test, selecting 3,200 larvae and noting their change into the pupa state. I planted them in detached groups (as chrysalids), under different soils, and at different depths (the latter to do away with cavilings). Some I placed just beyond the frost-line, others at the line, and, again, others just above the line. (Was there ever a chrysalid foolish enough, when forced to bury itself under *terra firma*, to leave its work of protection half-way done?) *In every instance* the pupation under ground was a failure. You well know how bewildered an ant becomes when its antennæ are removed; just so with *A. argillacea* when the chrysalis is entombed. I am giving you general outlines, which, I am sure, will appear plausible to you as an insect physiologist. Two of these moths (preserved in my cabinet) did actually burrow upwards from a depth of three inches, in soil that was quite loose and not compacted by the cold and the winds of winter (to say nothing of accidental pressure), and their wings were so much mutilated by their escape as to serve them no longer as instruments of flight. These experiments, repeated over and over, have proven to me the impossibility of anything bordering upon a *general pupation of A. argillacea under ground.*

2d. *That it hibernates as a moth.*—This is overwhelmingly true. Not under the leafless stalks of cotton, nor under the clods of dirt and rocks about them, but beneath the scales of pine trees in neighboring forests, in cotton-gin houses and elsewhere (particularly in the first-named), have I found the *A. argillacea* in numbers from December until May, wings perfect, no scale abrasions, and agility equal to that of any brood. I have found the moth in iron concretions not far from Cuthbert (Randolph County, Georgia), in the vicinity of Burgess Mills. This curious contrast you may note *en passant:* while the first broods (May to June 16) invariably appear first in the hammock-growth-bordered plantations, the moths of the last brood are found in midwinter principally amid the pine growths. On this point, however, I have no space to elaborate. Your own reasoning will be as good as that of any one else.

In another letter Mr. Humphreys states:

I found the moth (*A. argillacea*, Hübn.) hibernating on Saint Simon's Island, Georgia, February, 1876, and near Brunswick at the same time. I also found it in Randolph County, Georgia, November 8, 1876. The hibernating moth has been seen in barns and cotton-gin sheds from November to May, in the counties along Chattahoochie River, Decatur, Early, Clay, and in Thomas, Brooks, Lowndes, on the Glynn (Atlantic) coast.

And Professor Grote himself, in the paper in which he proposes the theory of migrations, says:

The last brood of worms changed into chrysalids in myriads on the leafless stems, clinging by their few threads as best they might, and disclosed the moth in the face of the frost, many of the chrysalids perishing. Afterwards, on sunny winter days, I have noticed the live moth about gin-houses and fodder-stacks, or the negro quarters.

Professor Grote adds: "Was this a true hibernation, or merely an accidental survival? The locality and the condition seem to me alike artificial." It appears to us that just the conditions described may be found on any plantation in the South, and that a few "accidental survivals" are all that is necessary to perpetuate the species in any locality. It has often been urged, by those who believe that the presence of the cotton-worm in our country is dependent upon the immigration of moths from other countries, that, did the species hibernate in our territory, the moths would be seen early in the spring. We believe that the only

reason it has not been observed more often at that season of the year is that it occurs in small numbers and that very few observers have thoroughly searched for it at that time. That moths are present and ovipositing on the cotton very soon after the young plants emerge from the ground has already been shown in the section on the first appearance of the worms.

Our conclusions are that the species does not hibernate as a pupa, but that in certain portions of our cotton belt the species does hibernate as a moth. The number of moths, however, which survive the winter is very small compared with the number of pupae of the last brood of the previous season.

It is probable that of those moths which mature before frosts sufficiently heavy to destroy the pupae occur, only the more vigorous individuals, and of them especially those which choose unusually-protected situations for their winter quarters, are able to survive the winter.*

As to localities in which the species hibernates, we conclude from the data drawn from a study of the past history of the insect that in the following-named places the moth usually survives the winter:

Texas.—Principally in the Colorado and Brazos bottoms, as far north as Grimes County and as far south as Victoria; occasionally as far north as Cherokee, *possibly* to Upshur, though not probable.

Louisiana.—The southeastern parishes along the river—East and West Feliciana, East Baton Rouge, and Iberville; possibly Saint Landry, Avoyelles, Concordia and neighborhood.

Mississippi.—The southwestern counties, near the river—Wilkinson, Adams, Amite, &c.

Alabama.—Principally in the "cane-brake" region; possibly in the southeastern counties, along the Chattahoochee.

Florida.—Principally in those northern counties near the Appalachicola—Gadsden, Jackson, Leon, &c.; possibly in adjoining cotton-growing counties.

Georgia.—Southwestern counties—Decatur, &c., along the Flint and Chattahoochee; in former years probably in the Sea Islands and coast counties.

INFLUENCE OF WEATHER.

It seems curious that observers should be so divided in opinion as they are concerning so simple a point as whether a mild or a severe winter is the more apt to be followed by a bad worm-season. Of the correspondents of the department, some hold one view, others the directly opposite opinion, while still others state that the degree of severity of the winter makes no difference whatever with the extent of the ravages the succeeding season. Those holding the last view base their opinion on the fact that they have actully known disastrous worm-seasons to follow cold and warm winters indiscriminately.†

Those holding the opposing views referred to also claim to found their opinions upon actual experience. The advocates of the view that a severe winter will be followed by the worm give as their explanation the fact that during warm winters the moths come forth from their hibernating quarters and die of hunger, whereas while in winter quarters and in the true state of hibernating somnolency not only is no food necessary, but they are less exposed to dangers of all kinds which would assail them if they flew out, attracted by sunshiny weather. The upholders

* For a full discussion of the theory of migrations of the moth, see special report, pp 109–121.

† This fact has been used as an argument for the migration theory.

of the theory that warm winters are more apt to be followed by the worm simply urge the idea that the severity of the colder winters kills the hibernating individuals.

The truth of the matter, as it seems to us, is that, other things being equal, a warm winter is more favorable to hibernation than a cold one. It seems to be true that the cotton-moth was originally a tropical or sub-tropical insect, and that only in favored localities within the limits of the United States can it hibernate at all. As we go northward the winters become too severe for survival from one season to another. Farther south, then, winters approaching to this northern severity must be unfavorable, while winters approaching those of the normal habitat of the moth will prove favorable. This is reasoning in the abstract. Actual experience seems to show that occasionally the greatest worm-years follow undoubtedly cold winters. This seems to have been the case with the season of 1873, in some parts of Alabama at least. Such instances we think, however, must be laid to a combination of other causes, working through a series of years; and that instead of the severity of the preceding winter having been the sole cause, the ravages of the worms would have been even worse had a mild winter come before.

Another and more important point concerning the influence of weather, brought out by the 1878 circular, was, do the worms flourish most in a wet or dry season? In the answers to this question great unanimity was found. With but few exceptions, the general opinion seems to be that wet years are the most disastrous caterpillar-years.

This fact (for such it undoubtedly is) has been always accounted for by the fact that wet weather produces a rank and succulent weed, of superior nourishing power to one dwarfed and dried by continued drought, and by the fact that in hot dry weather many worms are actually killed by the heat of the sun and by the oven-like heat of the earth when marching is attempted.

Another point, intimately connected with this last, is the one that the low, damp parts of a field are the ones where the worms always appear first in spring. This may be accounted for by the probable fact that on damp parts of a plantation the early cotton grows faster than on the drier parts; nectar is earlier secreted from the foliar glands; the hibernating moths are attracted by the nectar to that part of the field, and consequently more eggs are there laid.

Both of these facts have, however, been accounted for by a plausible theory, first publicly put forth by Mr. N. A. Davis, of Cherokee County, Texas, in 1866 or 1867, and which is as follows: The ants which are so numerous in cotton fields destroy many eggs, young larvae and pupae of *Aletia*. These ants abound most in dry lands, hence in such localities the worms are not permitted to multiply to so great an extent as in wet lands. On the other hand, in wet seasons the ants are kept in check, and consequently the worms multiply greatly.

Mr. Davis draws the following practical conclusions:

> Let no wet lands be planted on which the ant cannot live, nor let the highlands be plowed while wet to destroy the ant, and I am persuaded that the cotton crop will never be destroyed by the worm again. The observance of these facts will do more than all the poisons discovered and all the poison-distributers combined to protect the planter in his toil and guarantee him the rewards of his hands.

Almost simultaneously with the letter from Mr. Davis in one extreme of the cotton belt came a communication from Mr. J. C. Brown, of Willet, Barnwell County, South Carolina, the other extreme, expressing almost precisely the same views. Mr. Brown introduced this in his reply to the

1878 circular, which he had retained until this time to make further observations. He says:

The common ant maintains an equilibrium *when it is not too wet*. The ant will destroy the eggs unless the rainy weather keeps it in its retreat. This is the reason that a dry season is never a caterpillar one.

Upon receiving this we wrote to Mr. Brown for further particulars, and received the following reply:

DEAR SIR: In answer to yours of the 29th instant in relation to cotton-worm and whether the common ants were destructive to it, would reply that I have observed the ant on the cotton plant and apparently seaching it for prey. During sunny weather they are numerous, every cotton plant having several crawling over it, and they do destroy the eggs of the cotton-worm, for I have seen them stop as soon as they came across them and eat and carry them away. In wet weather the ant has retreated to its quarters and few can be found anywhere in the cotton field, and the caterpillars have undisturbed opportunity to multiply and increase.

We have the worm here now in force, and would be greatly damaged, but its first appearance was two weeks too late. And I have noticed that my theory of the ant has had additional substantials for its support, for during four or five sunny days there is a decided increase and activity on the part of the ant and a marked decrease of the same on the part of the worm.

Yours, respectfully,

JAMES C. BROWN.

WILLET, BARNWELL COUNTY, SOUTH CAROLINA.

This same idea is again expressed by Mr. Douglass M. Hamilton, of Saint Francisville, La., in his report, in which he says: "Ants of many kinds are found preying on them *in good weather, but not in bad*, and this is the reason given why the worm increases so much faster in rainy, wet weather than in dry and fair weather."

Mr. Wm. V. Keary, of North Bend, Cheneyville, parish of Rapides, Louisiana, December 17, 1877, in writing to J. Curtis Waldo, says: "The cotton-caterpillar requires a wet season to accumulate, as such weather is destructive to its natural enemy, the ant, and also an insect called the ichneumon," &c.

The following extracts from Mr. Trelease's note-book are of interest in this connection:

September 10, 1879.—On the second place, where 100 acres are eaten out entirely, I find thousands of nearly-grown aletias crawling in every direction. In wet places they are not so much molested by ants, for there are few of these; but on dry, sandy places I find ants killing many larvae. * * * Can it be that aletia first appears in wet places because the ants are not so numerous there as on high, sandy places? Early I found caterpillars on both bottom and ridge land. Were not most of the latter killed? This theory must be taken in connection with that of the nectar, for certainly there are more eggs laid in wet ground. Can it not be that this is partly due to the fact that more moths are excluded in such places and lay their eggs without leaving them?

The one sentence, "*Early I found caterpillars on both bottom and ridge lands*," forms a strong argument for Mr. Davis's theory.

And now as to our own conclusions: If it can be shown that the number of cotton-worms actually killed by the ants is as great as stated by the upholders of the theory, then there can be no doubt but that it accounts for observed facts. But what evidence we have collected as to the efficacy of the ants as destroyers of the cotton-worm seems hardly sufficient to warrant us in unqualifiedly supporting so broad a theory. We can safely say, though, that the agency of the ants is *one* of the prominent factors in bringing about the dry-weather scarcity or wet-weather abundance of the cotton-worm. The most important time for the ants to be pursuing their good work is among the early broods of worms—in May and June. Every worm killed at this time saves the cotton from hundreds later. The numbers of individuals in the earlier

broods are small, and more appreciable work can then be done. Later in the season the abundance of the worms, if they have been protected by wet weather earlier, is so marked that an ordinary change of the weather has small influence over them.

The law, then, which we should lay down for the influence of weather upon the cotton-worm, taking all evidence into consideration, would be, A mild winter, followed by a rainy May and June, will usually bring a destructive "third crop" of the worms, while an opposite state of the weather will be more likely to bring about comparative exemption.

NATURAL ENEMIES OF THE COTTON-WORM.

Prior to any remarks upon remedies comes naturally a discussion of this subject, for the encouragement of the natural enemies of any injurious insect is the first remedy that suggests itself. In order to pursue this subject to the best advantage, it will be necessary to divide it into two heads—vertebrate and invertebrate enemies.

VERTEBRATE ENEMIES.

Of mammals but five have been observed to devour the cotton-worm in any of its stages, although, without doubt, several others have the habit. These are three domestic and two wild—hogs, dogs, and cats, and coons and bats.

The destruction of cotton-worms by the domestic mammals being only an exceptional occurrence, and then very limited in extent, we will not dwell upon it.

One of the most effective mammalian enemies of the cotton-worm is the common "leather-winged bat" (*Vespertilio Sp.*). This animal has often been observed to catch the moths on the wing at night, and Mr. Trelease observed many bats around the jujube trees on which the moths were collected at night, repeatedly darting under and each time catching a moth. It is hard to estimate the amount of good which is accomplished in this way, as with each female moth is usually destroyed some hundreds of embryo worms.

We have the testimony of Mr. R. B. Dunlap, of Boligee, Ala., as to *coons* eating the worms. It is probable also that both skunks and opossums do some good in the same way.

Our list of birds is a longer one. It is probable that the planters in general do not sufficiently appreciate the amount of good which birds as a class do for them; and there are many who at this late date insist that no bird will touch the cotton-worm.

From multiplied evidences it seems clear, notwithstanding contrary reports, that much can be done toward the extermination of this pest with the aid of domestic fowls where poisons are not used; the latter contingency, of course, rendering it necessary to carefully isolate the fields from poultry.

And now let us turn from the consideration of domestic birds to that of wild birds. It has long been noticed that the cotton near the edge of the field where there were trees and bushes was not eaten by the worms, and this we can safely ascribe to the good offices of birds. In many parts of the South the amount of good performed by these little friends of the planters is not appreciated, and they are shot indiscriminately by the ignorant freedmen and others. The subject as to what particular species destroy the worms has been studied but little in this investigation, and we are obliged to rely upon the reports of correspondents. From these we have gathered the following partial list:

1. The painted bunting or nonpareil (*Cyanospiza ciris*, Linn.). This bird was found nesting on cotton at Macon Station, Ga., and as, according to the best authorities, its food is to a great extent insects, it may safely be put down as a destroyer of the cotton-worm.

2. The indigo bird (*Cyanospiza cyanea*, Baird). Observed by Mr. Trelease to destroy the cotton-worm.

3. The mocking-bird (*Mimus polyglottus*, Linn.). This bird, whose food consists principally of insects, has been reported from all over the South as being a great cotton-worm eater.

4. The bluebird (*Sialia sialis*, Baird). The food of this bird also consists principally of insects, and it has often been seen to destroy the cotton-worm.

5. The rice-bird, or bobolink, or reed-bird (*Dolichonyx oryzivorus*, Swainson), is reported by Professor Willet to feed upon the cotton-worm.

6. The "yellow oriole" (*Icterus baltimore?*) has been seen by Mr. G. W. Smith-Vaniz, of Canton, Miss., in numbers, devouring the cotton-worm.

7. The "yellow-jacket" (*Chrysomitris tristis?* Bonap.). This is a popular name, which is extremely indefinite, and cannot be found among the popular names adopted by modern ornithologists. It may refer to the common yellow-bird, or thistle-bird, or American goldfinch.

8. The bee-martin or king-bird (*Tyrannus carolinensis*, Baird). This bird, which feeds almost exclusively on winged insects, is perhaps the oftenest quoted as a cotton-worm-moth destroyer of all birds. It is, according to one correspondent, a common sight to see them darting about a field towards dusk, catching the moths on the wing or searching for them under the leaves.

9. The barn-swallow (*Hirundo horreorum*, Barton). This bird also has been observed to catch the moth on the wing.

10. The night-hawk or bull-bat (*Chordeiles Virginianus*) has been often seen to catch adult *Aletia* on the wing at dusk.

11. Red-wing blackbird (*Agelaius phœnicus*, Vieillot). These birds destroy immense unmbers or the cotton-worms.

12. Cow blackbird (*Molothoris pecoris*, Swainson).

13. Rain-crow or yellow-billed cuckoo (*Coccygus Americanus*, Bonap.). "The rain-crow feeds voraciously on them" (W. A. Harris, Isabella, Worth County, Ga.). All through Georgia and Alabama this bird is first mentioned in answer to the question, "What birds feed on the cotton-worm?"

14. Loggerhead or Southern shrike (*Collyris ludovicianus*, Baird).

15. The field sparrow (*Spizella fusilla*).

16. The chipping sparrow (*Spizella socialis*).

17. The song sparrow (*Melospiza melodia*).

18. The lesser sap-sucker (*Picus pubescens*, Linn.).

19. The wild turkey (*Meleagris gallopavo* var. *gallopavo*). Concerning this bird Mr. Trelease says: "Wild turkeys frequent Mr. Melton's plantation in search of the caterpillar, and the plantation is covered with their tracks. They are seen here, and I believe they have been seen catching the worms." Mr. P. D. Bowles says: "The wild turkey has been known to feed upon them in the field near the swamps," and Mr. J. N. Gilmore remarks, "The wild turkey is particularly fond of them."

20. The quail (*Ortyx Virginianus*, Bonap.) feeds upon the cotton-worm, according to Professor Willet.

21. Partridge, ruffed grouse or pheasant (*Bonasa umbellus*, var. *umbellus*, Stephens).

22. Prairie chicken, prairie hen, or pinnated grouse (*Cupidonia cupido*, var. *cupido*, Baird).

The great majority of our correspondents replied that "all birds" or "all insectivorous birds" eat the worms, without specifying the kind, and the list is made up of the commoner species which are incidentally mentioned, and may therefore be accepted as containing the names of those birds which perhaps do the most good.*

The good will with which the native sparrows destroy the cotton-worm and the reported efficacy of the English sparrow in ridding the Northern cities of the canker-worm have led many Southern planters to believe firmly in the feasibility and advisability of introducing this latter bird upon the Southern plantations. And we have received many letters urging us to experiment in this direction, but we felt that the subject should be carefully looked at on all sides before taking the course desired by our correspondents. In the special report we quoted the more important discussions of the sparrow question which have been published in this country. In this place we can only state, in a few words, the facts brought out by these discussions.

Although a few observers are favorably disposed to the English sparrows, nearly all of the American ornithologists unite in asserting their belief that the introduction of this bird was a great calamity. The grounds for this belief have been stated as follows:†

1. They neglect entirely, or perform very insufficiently, the business they were imported to do. In spite of some good service at one season of the year in a few particular localities against some particular kinds of insects, the state of our shade-trees remains substantially as it was before their introduction. Some of the decrease of noxious insects at times is due to their periodical decrease, with which the sparrows have nothing to do; and in spite of assertions to the contrary, people are still scraping trees and still employing the usual defenses against insects in precisely those places where it was said that the sparrows had done the business.

2. They attack, harass, fight against, dispossess, drive away, and sometimes actually kill various of our native birds which are much more insectivorous by nature than themselves, and which might do us better service if they were equally encouraged.

3. They commit great depredations in the kitchen-garden, the orchard, and the grain-field.

4. They are personally obnoxious and unpleasant to many persons.

5. They have, at present, practically no natural enemies nor any check whatever upon limitless increase. This would be undesirable, even in the case of the most desirable birds; as the case stands, *we are repeating the history of the white weed and the Norway rat.* ‡

The discussions to which we have referred bore upon the desirability of introducing this bird into the Northern cities. For our present purpose there are other points to be considered, the most important of which is that this species would probably not stay in the cotton fields if it were introduced there, as it prefers to live in cities. This point has been verified by experience. A year or so since the sparrows were introduced into Bibb County, Georgia, with a view of destroying the cotton-worms; but they almost immediately forsook the plantations, and were last year seen nesting about a church in the city of Macon. Reports have also reached us of the attempted colonization of this bird in

*In the special report there is given a list of the insectivorous birds occurring in the cotton belt. This list was prepared by Mr. Robert Ridgeway, ornithologist to the Smithsonian Institution.

†See paper by Dr. Elliott Coues, American naturalist, August, 1878, quoted in Special Report, pp. 152–155.

‡Any person desiring to study the subject further will find a complete bibliography of the sparrow controversy in the Bulletin of the Hayden Geological and Geographical Survey of the Territories, vol. v, No. 2, compiled by Dr. Elliott Coues.

parts of the cotton-growing regions of Texas. The persons who carried this plan out did not learn from experience of the bad habits of the sparrow for the simple reason that he would not stay. In a very short time after their importation in considerable numbers, hardly a sparrow was to be found in the State. Persons interested in the experiment believed that the climate was too warm, and suggested as the only means of bird relief the importation of some South American sparrow of similar habits. We very much doubt, however, if any bird could be introduced which would prove a greater blessing than any one of many birds indigenous to the cotton States, if equally encouraged. My own advice is, after careful consideration of the subject, cultivate and protect the native birds, and drop all thought of the English sparrow for the present. Protect the native insectivorous birds, by putting a stop to their destruction by ignorant individuals and by birds of prey. There are two birds in particular which should always be killed on sight. These are the blue-jay and the cow-bird. We quote from Professor Aughey concerning these two bad characters:

Among the birds most hostile to birds are the blue-jays. They rob the nests of other birds of their eggs. Wantonly they often kill even the young and throw them out of the nest. The increase of jays is, therefore, incompatible with the general increase of insectivorous and other small birds, especially of those that nest on trees and shrubs. It is hard for the naturalist to give up such a dandy among birds, but as he is only a blackleg in fine clothes, the feathered tribes are healthier and safer without his society.

Perhaps no bird causes such wholesale destruction among birds as the cow-bird. Its habit of laying its eggs in the nests of other birds, one only in a nest, and leaving them to be hatched out and nourished by the foster parents, to the destruction of their own kind, merits banishment and death. Even crows and magpies do much less harm to other birds than jays and cow-birds.

In addition to doing away with these active enemies of the insectivorous birds, the latter should be encouraged in every possible way to nest around plantations. For the martins, native sparrows, and others that will make use of artificial nesting places, boxes should be provided, if possible. Children should be taught to protect, not to destroy them, and a general sentiment in favor of birds should be established. Not only would the cotton-worm suffer, but a good step will have been taken towards releasing the planter from the tyranny of his other numerous insect enemies.

Among reptiles, several varieties of lizzards have been reported by correspondents as eating cotton-worms, but none have mentioned names or forwarded specimens, so we are unable to give specific names. Land turtles are also reported to be fond of the worms, and as might naturally be expected, the common toad is said to feast upon them.

INVERTEBRATE ENEMIES.

The invertebrate enemies of the cotton-worm are, with the exception of the spiders, all true insects. These enemies may be divided, for the sake of convenience, into those *predaceous* and those *parasitic* upon the cotton-worm in one or another of its stages.*

*The use of these two words in contradistinction the one to the other is to be deprecated, under ordinary circumstances, from the fact that they are not sufficiently definitely limited in their meaning, and that there are many insects which it would be difficult to designate by the one word or the other. In the present case, however, no such difficulty occurs, and we adopt the terms *predaceous* and *parasitic* as affording the most convenient division of this head.

PREDACEOUS.

SPIDERS (*Araneida*).—That the numerous spiders, always to be found about cotton fields, do a considerable amount of good in capturing the cotton-worms and the cotton-moths cannot be doubted. The jumping spiders (*Attides*) destroy many young larvae and occasionally are able to capture a moth. Plate IX, fig. 5 represents a species which was observed by Mr. Trelease to prey upon the cotton-worm.

The large nesting spiders (*Epeirides*), of which the commonest species through the Southern cotton fields is *Argiope riparia* (*Epeira riparia* of older authors), catch the moth in their webs.

A common and doubtless a beneficial species, which I observed upon the cotton plant in Alabama, is a large pale-green spider, with long spiny legs (*Oxyopes viridans*). (See Plate IX, fig. 6.)

Clubiona pallens was found nesting in cotton quite abundantly. They fold the cotton leaves in much the same manner as do the cotton-worms, forming thereby a sort of basket, in which they deposit their eggs. They may at once be distinguished from the *Aletia* web by the whiteness of the silk of the former.

Among the smaller species which have been noticed upon the plant among the young worms may be mentioned *Attus fasciatus*, *Theridium globosum*, *Theridium funebre*, *Epeira stellata*, *Singphia communis*, *Tetragnata extensa*, *Metha sp., and Xysticus sp.**

Of the true insects that prey upon the eggs, larvae, or adult of *Aletia argillacea*, some 35 species have been observed by the correspondents and observers of the department. Of these we shall speak in their regular scientific order, beginning with those belonging to the NEUROPTERA, the lowest order of insects.

APHIS LIONS (*Neur.*, gen. *Chrysopa*). The aphis lions are the larvae of the "golden-eyed lace-wing flies"—insects with slender bodies and extremely delicate, gauze-like wings. Their color is usually green and their eyes golden (represented in all stages in Plate IX, figs. 7 and 8.) Upon being disturbed, they emit a disagreeable, fetid odor. Their eggs are white and are supported by long foot-stalks, as shown in the figure, usually upon plants infested with plant-lice. The larvae are active and extremely voracious. There are two or more broods in the course of the summer, and the last brood winters in the chrysalis state, protected by a compact, round, whitish cocoon.

These aphis lions are abundant upon the cotton-plant throughout the summer, and in the early part of the season do the planters much good by destroying the cotton-aphides in large numbers. Later in the season they devour the eggs and newly-hatched larvae of the cotton-moth.

MOSQUITO-HAWKS, DRAGON-FLIES, or DEVIL'S DARNING-NEEDLES (*Neur.*, Fam. *Libellulidae*).—These insects, in the adult stage, are so well known as not to warrant description. The eggs are laid in the water, either indiscriminately dropped or deposited around the stem of some aquatic plant. The larvae are predaceous, living upon other aquatic insects. The habits of the perfect insects are also predaceous. (We figure (Plate X, fig. 1) one of the most common species, *Libelula trimaculata*.) They catch and eat numbers of insects upon the wing.

In the next order, ORTHOPTERA, we find but one insect which preys upon *Aletia argillacea*; although in parts of Texas, according to Mr. Schwarz, the planters insist that the grasshoppers eat the cotton-worm!

THE REAR-HORSE, CAMEL-CRICKET, OR DEVIL'S RIDING-HORSE (*Man-*

*The determinations of the spiders mentioned in this report were made by Mr. George Marx, of this department.

tis Carolina). As useful an insect as occurs in the Southern States is known by the above popular names in different localities. Its food consists entirely of other insects, which it approaches stealthily and seizes with its powerful spined forelegs. The amount of good which it does in thus destroying noxious insects is hard to estimate. The capacity of each individual can be seen from the fact that in one night a single female has been known to kill and devour eleven Colorado potato-beetles, leaving only the wing-cases and parts of the legs.* The only objection to them seems to be that they are not sufficiently discriminating in choosing their prey, and beneficial as well as noxious insects suffer from their attacks. They seem to be especially fond of one another, and after sexual union the female frequently devours the male.†

The mantis winters in the egg state and its pecular egg-masses (see Plate X, fig. 2) are abundant and conspicuous upon tree twigs throughout the winter.

The next order, HEMIPTERA, contains several hard-working cotton-worm enemies.

THE SPINED SOLDIER-BUG (*Arma* [*Podisus*] *spinosa* Dallas).—This insect (Plate X, fig. 3) is a most useful one from its usual cannibalistic habits. Dr. Phares says, in answer to question 6 *a* of the 1878 circular:

> Many are said to do so, of which I cannot testify; but for the following I can; Soldiers-bugs pierce the caterpillar, suck their juices, and thus destroy them (see illustrative plate, Rural Carolinian, August, 1870, p. 683). The soldier-bug presents his lance, moves deliberately and steadily along till the caterpillar is impaled.

Specimens were also received from Mr. Trelease, with the remark that he had observed them on several occasions to kill the cotton-worm.

THE GREEN SOLDIER-BUG (*Raphigaster* [*Nezara*] *hilaris* [*Pennsylvanicus* of Fitch.]). (Plate X, fig. 4.)

This insect was figured by Mr. Glover in his report on Cotton Insects (Rept. Dept. of Agri., 1855, Pl. VIII, fig. 5, p. 93), and in the text spoken of as piercing cotton-bolls and sucking the sap. Mr. Bailey, of Monticello, Fla., is given as authority for the statement. It was said to be very abundant in the cotton fields.

Concerning its killing the cotton-worm, Professor Willet, in a recent letter to this department, has the following:

> A word about an enemy to the cotton-worm. At Montezuma, Macon County, Georgia, September 20, when collecting cotton-worms (*Aletia argillacea*) for experiments, I saw one extended in the air horizontally from a cotton leaf, holding on only by his two anal feet and contorting his body about as if in great pain. On examination, I found a plant bug had pierced him about the anus and was quietly sucking his juices. I had no vial nor box, and could only drop them in the basket with other larvæ. The next morning I found the caterpillar dead: but the bug was not to be found. I think, from the hurried sight I got, it is what Glover calls the green Plant Bug, Plate VIII, fig. 5. A gentleman living there told me he saw another cotton-worm impaled in its side by a similar bug.

It would, of course, be unsafe to accept the identity of the insects upon such insufficient grounds, but it is probable that, if not the same, Mr. Willet's insect was an allied species of Raphigaster. We have Mr. Glover's authority that either *hilaris* or a closely allied species is predaceous upon the Colorado potato-beetle. It is probable also that the same insect is meant by several of our correspondents, who enumerate "green chinches" as among the enemies of the cotton-worm.

THE THICK-THIGHED METAPODIUS (*Acanthocephala* [*Metapodius*] *femo-*

* See First Missouri Entomological Report, p. 169 (1869).

† See Packard's Guide to the Study of Insects, p. 575.

rata, Fab., *Rhinuchus nasulus* of Say).—Concerning the occurrence of this insect in the cotton-field, Mr. Glover said, in 1855:

These insects, though somewhat numerous, were never observed to suck the sap from the bolls, yet it would be well to investigate their habits more minutely before deciding whether they are injurious or not.

The following short account of the insect is from the department report for 1875, p. 129:

Acanthocephala (*Metapodius*) *femorata*, so called from its swollen, spiny thighs, is a large reddish-brown or blackish insect, quite abundant in the Southern cotton fields. It is very slow in its motions, and appears to be fond of basking in the sun. The thighs are strongly developed and spiny, especially on the under side, while the shanks have broad thin plate or leaf-like projections on their sides, which give these insects a very peculiar appearance. The eggs are smooth, short, oval, and have been found arranged in beads like a necklace on the leaf of white pine. The full-grown insect is said to injure cherries in the Western States by puncturing them with its beak and sucking out the juices, thus proving it, at least in one instance, to be a feeder on vegetable substances.

Its importance to the cotton planter is shown by the following account by Mr. Trelease:

Several bugs (*Hemiptera*) were seen to kill the cotton-worm. Early in the season great numbers of a large ill-smelling bug with dilated hind legs (*Acanthocephala femorata*) were seen in the weeds and shrubbery about the borders of the cotton fields, being very noticeable on account of its buzzing flight. After *Aletia* appeared in numbers, fewer of these bugs were seen, but they were several times seen to catch caterpillars and suck the juices of their bodies.

The full-grown insect is shown at fig. 1 of Plate XI. Planters will do well to avoid destroying either these insects or their eggs.

THE DEVIL'S HORSE OR WHEEL-BUG (*Prionotus cristatus*, Lin.; *Reduvius novenarius*, Say). (Plate X, fig. 5.)—Mr. Glover, in the 1855 report, mentions this insect as among the few beneficial to the cotton plant. He there mentions that he placed a young specimen of *Reduvius* in a box with ten caterpillars, all of which it destroyed in the short space of five hours.

Concerning the general habits of the insect, we refer the reader to an excellent account by Professor Glover, in the Department of Agriculture Report for 1875, p. 128.

For the activeness of the devil's horse in the cotton fields of the South, many correspondents have vouched, and planters should treat him like the friend that he is.

THE RAPACIOUS SOLDIER-BUG (*Sinea multispinosa*, De Geer, [Say's *Reduvius raptatorius*]).—This insect (Plate XI, fig. 2) is found all over the country, North and South, preying upon all kinds of insects. Like the last-named species, when young it devotes itself to plant-lice, but upon attaining its growth it attacks insects of a larger size and of more economic importance. In the North it has done a good work in destroying canker-worms, Colorado potato-beetles, and other pests, and during the past summer they were seen in considerable numbers about the cotton fields, engaged in killing the cotton-worms.

According to the editors of the American Entomologist, Vol. I, p. 207, the eggs of the rapacious soldier-bug are about the size of a common pin's head, are laid in two parallel rows upon the bark of limbs or twigs, and each egg is bordered round its tip-end with a fringe of short prickles.

When newly hatched, the young soldier-bugs may be frequently found in the curl of the common elm-leaf plant-louse (*Schizoneura Americana*), and also the common apple aphis (*Aphis mali*), busily engaged in devouring the lice; and it is more than probable that in the cotton fields they

will be found preying upon the cotton-louse (*Aphis gossypii*). The full grown insect is shown at Fig. 16. It is brownish in color, with a reddish stripe down the back of the abdomen. The front legs are greatly enlarged and powerfully spined, enabling the insect to hold its struggling prey. From these spines, and those upon the head, it has gained its scientific name, *multispinosa*.

In addition to these five hemipterous insects, many specimens of a small black and red bug were many times seen about the pupae of Aletia, and were often found within the loose cocoons. Although they were never actually observed to kill the chrysalides, their presence is suspicious, especially as upon examination their beaks were found to be of the short, broad, predaceous type. All of the specimens forwarded to the department were of immature individuals, from which it was impossible to ascertain the species. They were flat, nearly round, a trifle over one-tenth of an inch (3^{mm}) in length. The head and thorax were black; the abdomen had a broad red band around near the margin, and three narrow transverse white bands.

Although we have several parasites on the cotton-worm belonging to the next order, DIPTERA, the only predaceous insects from this order are the Asilus flies.

ASILUS-FLIES OR ROBBER-FLIES (Dipt. fam. *Asilidae*).—The large buzzing fly, with long slender abdomen and thick hairy throat, is a familiar sight in the cotton field to the observing planter. A popular name was never more appropriately applied than that of robber-flies ("*raubfliegen*"), given to these flies by the Germans. They are among the most rapacious of insects; but not only are they as indiscriminating as other predaceous insects, but some species seem actually to *prefer* beneficial insects as a steady diet. There is almost no enemy which the apiarist fears more than these "bee-killers," as some species are termed.

Mr. Thompson, in an article in the Rural World for September 12, 1868, stated that he had observed one individual Asilus-fly to destroy 141 bees in one day.

Three species have been captured in the cotton fields of Alabama. These are *Erax apicalis*, Wied., *Diogmites discolor*, Lw., and *Dionyzias?* sp. By far the most abundant species was *Erax apicalis*, Wied. This species (represented by Plate XI, fig. 3) varies from an inch to an inch and a quarter in length (25 to 32^{mm}), and has a wing expanse of nearly an inch and a half. The abdomen is black, with silvery markings above and whitish below. The top of the thorax is yellowish-white and brown above, as seen in different lights. The legs are spiny and light-brown in color and the face is nearly white. In the summer of 1878 I observed large numbers of these insects flying around the cotton fields in the vicinity of Selma, Ala., occasionally darting to the ground and seizing some insect. With some difficulty a specimen was captured while engaged in sucking the juices of a young grasshopper (*Caloptenus* sp.).

During the past summer Mr. Trelease forwarded several of these insects to the department from Minter, Dallas County, Alabama. He stated that they were very abundant in the cotton fields, and had been several times seen to catch the cotton-moth on the wing and devour it. The rapacity and the capacity of these flies have been seen in the statement of Mr. Thompson; and even supposing each individual in the southern cotton fields in the course of a day to kill cotton moths in numbers that shall seem small in proportion to the number of bees which Mr. Thompson actually saw them kill, we shall be obliged to put them down as among the very best friends of the planter. The benefits derived from the abundance of this insect will, however, be greatly detracted from

wherever bees are kept, and it is also more than probable that its fondness for insects of this sort leads it to kill "wasps" and "hornets," some of which, as will be shown further on, are very efficient enemies of the cotton-worm. The harm done in the latter way is undoubtedly more than compensated for by the cotton-worms killed, but the former habit is one which cannot be condoned, and which quite effectually spoils the character of these otherwise beneficial insects.

The next order, COLEOPTERA, contains very many predaceous insects, and more species from this order have been found to prey upon the cotton-worm than from any other.

TIGER-BEETLES (*Coleopt.*, fam. *Cicindelidae*).—The Carolina tiger-beetle (*Tetracha Carolina*, Linn.) was mentioned by Mr. Glover in the Department of Agriculture Report for 1855 (p. 109) as among those insects "beneficial to the cotton plant" by destroying its enemies. He remarks that "this species" appears not to be so partial to the light of the sun as some other species, but often conceals itself under stones. It is also seen much more frequently in the cotton fields during cloudy weather, toward evening, than in a fervid midday sun. Many specimens of this beetle have been forwarded to the department during the past summer from the Alabama cotton fields; Dr. A. W. Hunt, of Denison's Landing, Perry County, Tennessee, mentions it in his list of insects preying upon the cotton-worm. Plate XI, fig. 4, represents very fairly the perfect insect. It is usually about three-fourths of an inch (19^{mm}) in length, is of a brilliant metallic color with purple and coppery reflections as viewed in different lights. The eyes, legs, and mouth parts are of a dirty white. The Carolina tiger-beetle can at once be distinguished from the only other North American representative of the genus *Tetracha* (*T. Virginica*) (see Plate XI, fig. 5) by the comma-shaped yellowish mark at the end of each wing cover.

Other tiger-beetles belonging to the typical genus *Cicindela* are found in the cotton fields performing the same good offices. We figure several common species in order to give a general idea of the group. At Plate XI, fig. 6, a larva and several species in the adult form are shown.

GROUND-BEETLES (*Coleopt.*, fam. *Carabidae*).—Almost all of the beetles belonging to this family are carnivorous, and the family as a whole does much good by destroying injurious insects. These insects are to be found during the day under sticks and stones and under the bark of trees, from which places they go out at night to hunt for their prey. The larvae live in similar situations and are also nearly always predaceous. The generalization is made by Packard that they are "generally oblong, broad, with the terminal ring armed with two horny hooks or longer filaments, and with a single false leg beneath." Of these beetles all which are to be found in the cotton fields will undoubtedly lose no chance to destroy the cotton-worms. A correspondent from Texas speaks of "the large green ground-beetle" as destroying the worms. These are, in all probability, *Calosoma scrutator*, Fabr., shown at Plate XI, fig. 8. According to Harris, this insect is known to ascend trees in search of canker-worms and similar insects. Another beetle of similar habits is *Calosoma callidum*, shown at Plate XI, fig. 7. Mr. Glover, in the 1855 report, figures a species of *Harpalus*, probably *H. caliginosus*, Say (see Plate XII, figs. 1, 2), and in the text refers to it as being abundant in the cotton fields and beneficial by destroying the different enemies of the cotton plant.

SOLDIER-BEETLES (*Coleopt.*, fam. *Lampyridae*, genus *Chauliognathus*, Hentz).—The family *Lampyridae* is popularly known as the fire-fly family, and the adult beetles are too well known to need description. In the perfect state they are nearly all vegetable feeders, while the larvae are nearly

all carnivorous. The larvae of *Chauliognathus* are long, slender, flattened, tapering toward the ends, active, with large jaws. They are usually blackish, with pale spots at the angles of the segments. *Chauliognathus Pennsylvanicus* (Plate XII, fig. 4) was found by Mr. Glover to be so plentiful in the cotton fields near Columbia, S. C., that four to six might be taken from one bloom alone. They seem to feed entirely upon the pollen or nectar of the flower, and would so busily engage themselves in feeding as scarcely to notice the approach of mankind. When issuing from the flower they would nearly always be so covered with masses of pollen as scarcely to be recognizable. They, without doubt, served a good purpose in assisting the thorough fertilization of the flower. This beetle is about three-quarters of an inch in length, with black head, eyes, legs, and antennae. The thorax and wing-cases are orange-yellow, with a large dark spot in the center of the thorax, and a broad black stripe down the center of each wing-case, thus leaving a narrow margin of orange-yellow all around. The yellow-margined soldier-beetle (*Chauliognathus marginatus*) was found by Mr. Glover to take the place of the Pennsylvania soldier-beetle in Florida. This insect (Plate XII, fig. 3) is about half an inch in length, and may be distinguished from the laeter species by the head and lower part of the thighs being orange. The harm done by the adults is slight, if any, and the good accomplished by the larvae is probably considerable. We have no definite report of their having been observed to destroy either the eggs or the young of the cotton-moth, yet from their well-known proclivities they probably do so, and from the numbers in which the adults occur, we can readily suppose that no small amount of good is done in this way. At all events, the soldier-beetle should not be destroyed.

LADY-BIRDS, OR LADY-BUGS (*Coleopt.*, family *Coccinellidae*).—The "lady-birds" are better known, perhaps, than any other family of beetles. They are small, round, and hemispherical, usually red, yellow, or black, with spots of one or the other of these colors. All are carnivorous except *Epilachna*. The eggs are usually long, yellow, and oval, and are laid in patches, often in the midst of a group of plant-lice, which the newly-hatched larvae greedily devour. The larvae (see fig. 29) are long, soft-bodied, rather pointed toward the end, and are quite active. The jaws are small and inconspicuous. They are often quite gaily colored, and covered with scattered tubercles, spines, or tufts of hair. They attain their full growth in three to four weeks. When about to transform to pupae they attach themselves by the end of the body to a leaf or twig, and either throw off the old larva skin, which remains around the tail, or retain it around the pupa for protection. The pupa is small and rounded, simulating the true beetle. The perfect insect comes forth in about a week. The larvae feed upon plant-lice and other small insects, of which they destroy immense numbers. The adult beetles also destroy other insects, although in lesser numbers than the larvae. Quite a number of species of the lady-birds are found in the cotton-fields doing good work, a few of the most common of which we figure and briefly describe.

Coccinella novemnotata, Herbst. (Plate XII, fig. 8, and pupa), is light yellowish-red in color, and may at once be distinguished by the nine black spots upon its wing-covers, arranged as shown in the figure, four upon each wing-cover, the two hind ones being the larger, and one in front on the middle line. *Coccinella munda* (Plate XII, fig. 7) is a smaller species of precisely the same color, but without any spots upon the wing-cover. Its thorax is black, with two small light spots. *Hippodamia convergens* (Plate XII, fig. 6) resembles the preceding in general ground color. It is larger and more elongated. On the wing-covers are thir-

teen small black spots. The thorax is black, with a light yellow margin, and two lines of the same color approaching a V in shape. *Hippodamia maculata* (Plate XII, fig. 5) is pink in color, with ten large black spots on the wing-covers, of which two are upon the middle line. The thorax is pink, with two large black spots, and the head is pink, with black eyes. It is smaller than the last named species. *Coccinella venusta* (Plate XII, fig. 9) is larger and broader. It is pink in color, with ten large black spots upon the wing-covers, of which the hind two blend into each other across the middle line. The inner middle spots are shaped like inverted commas. The thorax is pink, with four black spots, of which the two hinder ones meet across the middle line to form a V. *Chilocorus bivulnerus*, Muls. (the twice-stabbed lady-bird), is hemispherical in form, and shiny black in color. A little in front of the middle of each wing-cover is an irregular bright red spot. The thorax is black, with a whitish border, and the head is whitish, with black eyes.

That these lady-birds destroy many eggs and newly hatched worms of the cotton-moth there can be no doubt. Mr. Trelease reports:

I have seen but one insect destroying the eggs of the *Aletia*, viz, the larva of one of the lady-birds (*Hippodamia convergens*). This was on the 26th of August. The larva was searching the lower surface of a leaf, apparently for *Aphides*, when it encountered an *Aletia* egg, which it immediately bit with its mandibles; but, as if disliking its taste, it left the egg uneaten and passed on. Later, I saw this same larva bite another egg, and this, too, was left without further disturbance, but of course both eggs were killed. Though many hours were spent in looking for further attacks upon the eggs of *Aletia*, the difficulties necessarily attendant upon such observations prevented me from seeing any more. From the actions and known proclivities of the lady-birds known as *Hippodamia convergens*, *H. maculata*, *Coccinella munda*, and *C. 9-notata*, all of which are found in abundance on cotton plants, and of *Chilocorus bivulnerus*, one adult of which was seen searching the leaves of cotton, I suspect that they all destroy these eggs more or less commonly.

In Dr. Phares's report an unknown enemy of the cotton-worm was spoken of. Concerning this insect, in a later letter, Dr. Phares says:

In my report upon the cotton-infesting insects made last autumn, in that portion in which mention is made of insect enemies of the *Aletia*, one is referred to and obscurely figured on paper. I find that my son had drawn it separately and distinctly, and it proved to be a *Coccinella* or *Hippodamia*. We are both of the opinion that it is the larva of *Coccinella novem-notata*, so abundant on the cotton plant.

In his report, Dr. Phares speaks of these larvae as feeding upon the *chrysalides* of *Aletia*. This might seem at variance with the well-known habits of these larvae (feeding, as they do generally, upon smaller insects, or, at all events, upon insects of but slightly larger size than themselves), to attack so large an object as the chrysalis of the cotton-worm; but Mr. Glover has placed on record a similar instance. He says:

The perfect lady-bird also destroys *Aphides*, but not in such numbers as their larvae in which state it also destroys the chrysalis of the butterfly (*Argynnis columbina*) seen so often in the cotton fields. I have repeatedly observed them in Georgia killing the chrysalides of this butterfly, which hung suspended from the fence-rails and on the under side of the boughs of trees and shrubs. It appears to attack the chrysalis chiefly when soft and just emerged from the caterpillar skin. It is in this state that these wandering larvae attack it, and, biting a hole in the skin, feed greedily upon the green juice which exudes from the wound. Sometimes, however, it becomes a victim to its own rapacity, for the juice of the chrysalis drying up in the heat of the sun quickly forms an adhesive substance in which the larva is caught, and thus detained until it perishes.

It is probable, however, that the destroying of the cotton-worm chrysalis by lady-bird larvae is only of exceptional occurrence. In addition to the evidence already given, Mr. J. H. Krancher of Millheim, Tex., informs us that the lady-birds destroy the eggs of the cotton-moth, and Dr. E. H. Anderson mentions them among the cotton-worm enemies.

We figure (Plate XII., fig. 10) the *only* vegetable-feeding lady-bird in order that those interested may know what it is, and not consider it a beneficial species. It is known as *Epilachna borealis*, Thunberg. It is much larger than any before mentioned, is of a light reddish yellow color, with seven large black spots upon each wing-cover. The thorax is of the same color and has four small black spots. The head is concolorous with the thorax, and the eyes are black. Both the larvae and perfect insects feed upon the leaves of cucumbers, melons, squashes, and pumpkins—eat unsightly holes in them, and, when numerous, completely destroy the plant. Another beetle, of injurious proclivities, is often mistaken for a lady-bird by the planters, although it belongs to an entirely different family. This is the twelve-spotted Diabrotica, *Diabrotica duodecim-punctata*, Fabr. This insect is shown at Plate XII, fig. 11, and certainly does resemble Coccinella to the untrained eye. The principal points of difference between it and the common Hippodamias, which it most resembles, are that the Diabrotica is usually greenish, varying occasionally to yellowish, that it has twelve black spots arranged in parallel rows down the wing covers, and that the thorax is green and unspotted. The twelve-spotted Diabrotica belongs to the family *Chrysomelidae*, or leaf-eating beetles. Dr. Packard states that they devour the leaves of dahlias, and they are commonly found gnawing melons, squashes, and cucumbers.

In the next order, LEPIDOPTERA, it would be fair to suppose that the cotton-worm had no enemies, since predacious insects are extremely rare in this Order.

In spite of this fact, many Lepidopterous larvae when placed in confinement will destroy one another, and facts have developed which warrant us in putting the boll-worm drown as an occasional enemy of the cotton worm.

THE BOLL-WORM (*Heliothis armigera*, Hübn.).—Although the boll-worm may be put down as almost omnivorous, and although it becomes cannibalistic in confinement (so much so that in breeding but one can be kept in the same cage, and in sending through the mails one box had to be allowed for each individual), we hardly expected to see it develop any characteristic which could be called beneficial; yet, according to the observations of Mr. Trelease, it seems to have done so. Mr. Trelease says in his report:

> Owing to its tough integument, the pupa of *Aletia* seems to be freer from insect attack than the larva is, yet even its hard skin does not always save it. About the middle of August I first noticed what appeared to be an anomalous preparation for pupation in the boll-worm (*Heliothis armigera*), for I found several full-grown larvae of this species with leaves closely webbed around them, precisely as *Aletia* webs up before changing to a pupa. An examination of one of these, however, showed me that the boll-worms had not webbed them about themselves, but had insinuated themselves into leaves folded and preoccupied by *Aletia*, the latter having already passed into the pupa state; and they had done this for the express purpose of feeding on these pupae; *many cases of this sort were seen.*

So plain a case as this requires no comment. It is of interest scientifically but its practical bearings are slight. Earlier in his report, bearing on this same point, Mr. Trelease says:

> No Lepidopterous enemies of *Aletia* larvae were observed by myself, but Dr. Lockwood of Carlowville, Ala., says that a number of years ago he saw a large green larva devouring numbers of cotton-caterpillars. From what we know of the habit of the boll-worm (*Heliothis armigera*) it seems not at all unlikely that these larvae may have belonged to that species.

It will also be interesting in this connection to state that the boll-worms have been observed to kill one another on the plants, in open air, and perfectly unmolested, as will be shown later.

As bearing upon this point of other Lepidopterous larvae attacking the cotton-worm, we quote the following sentence from Dr. Anderson's report: "I have never seen the worm attacked by any other insect than the *grass-worm* and then only when brought in contact." Concerning this same insect, *Laphygma frugiperda*, of Smith & Abbot (*Prodenia autumnalis* of Riley) Mr. Glover, in the Department of Agriculture Report for 1855, p. 78, says:

The grass-caterpillars, when in confinement, very often kill and devour each other, and when one is maimed in the least it stands a very poor chance for its life. Several intelligent planters state that when the grass and weeds are entirely devoured, and no other vegetable food is to be found, they will attack each other, and feed upon the still living and writhing bodies of their former companions. One grass-caterpillar which was kept in confinement, although furnished with an abundance of green food, actually appeared to prefer to feed upon other caterpillars, no matter of what kind, so long as their bodies were not defended by long bristling hairs or spines.

It is in the next order, HYMENOPTERA, that we find the most effective enemies of the cotton-worm.

WASPS (*Hymenopt.*, fam. *Vespariae*).—These well-known insects, as a class, although they occesionaly do some harm by injuring fruit or by killing honey-bees, may, on the whole, be called very beneficial insects. Not only do they devour injurious insects themselves, but they also store them up as food for their young. Concerning the actions of certain wasps in the cotton fields, we cannot do better than to quote again from Mr. Trelease's report:

Wasps frequent the cotton plant in considerable numbers, being attracted, like the ants, in part by the nectar secreted by the plant: and there is much reason to believe that all of the species which visit the plant feed more or less commonly upon the caterpillar or larva of *Aletia*. I am led to this conclusion by the following observations. On the 5th of August, when larvae of the fourth brood of *Aletia* were very abundant in the swamp-cotton, I saw a large red and yellow wasp—*Polistes bellicosa*, Cresson (Plate XII, fig. 12) hunting for them. Carefully walking around the holes eateg through by the caterpillers, she explored their borders with her antennae, as if feelimn for the larvae; and each time that she found one in this way she quickly sprang after it, but at the same instant the larva threw itself from the leaf; so that, while I was watching her, I saw no less than eight escape, the ninth being caught and eaten. Occasionally she would stop hunting long enough to sip a little nectar from the foliar glands of the plant, and then the chase was resumed. I was very much surprised to see that she relied entirely on the tactile sense of the antennae for finding her prey. Though possessing well-developed ocelli and compound eyes, she seemed to make little use of them; and repeatedly I saw her alight on a leaf close to a caterpillar without paying any attention to him till she touched him with her antennae, when, as before stated, she would instantly spring after it. Observations of this sort were made several times on this wasp. Another large brown wasp (*Polistes* sp.) was also seen to catch larval *Aletias*, as also were a yellow-jacket hornet (*Vespa* sp.) and a common mud-dauber (*Pelopaeus caeruleus*, Linn.), and they all alternated hunting for caterpillars with feeding on nectar. Both species of *Polistes* were several times seen flying about with dead caterpillars, having previously reduced them to a pulpy mass with their mandibles. They were probably looking for some quiet place in which to eat them.

* * * * * * *

Early in September, while watching these moths as they fed on rotting figs, I saw many white-faced hornets (*Vespa maculata*) about the fig-trees. One of these hornets was seen to catch a two-winged fly nearly as large as itself. After killing it, the hornet proceeded to deprive the fly of its legs and wings, which were allowed to fall to the ground. The fly was then carried away. Under these same trees I found the wings of *Aletia* moths, and it looks from these as though these moths are sometimes killed by the hornet; still, I never saw a hornet in the act of killing a moth, or with the dead body of one, and I am aware their usual food is flies.

We find, then, that certain species of wasps destroy the cotton-worm, and also, without much doubt, the cotton-moth. The following species of so-called "wasps" were caught on the cotton plant in Alabama, and in all probability feed upon the worms: *Monedula Carolina*, Fab. (*Hymenopt.*, fam. *Bembecidae*); *Elis 4-notata*, Fabr.; *Elis plumipes*, Drury

(*Hymenopt.*, fam. *Scoliadae*); *Pelopœus cœruleus*, Linn. (fam. *Sphegidae*); *Polistes bellicosa*, Cress.; *Vespa Carolina*, Drury.

ANTS (*Hymenopt.*, family *Formicariae*).—The predaceous insects from which the cotton-worm suffers the most are, without doubt, the ants. These insects, from their warlike habits and the enormous numbers in which they occur, seem peculiarly fitted to hold in check even so dangerous an enemy as the cotton-worm. The efficacy of ants as cotton-worm destroyers has been noticed by but few writers upon the cotton-worm, and indeed there are some who insist that they never attack it. During my own stay at the South I never was able to see ants attack a worm *upon* the plant. Upon the ground, however, the case was far different. There I repeatedly saw ants attack and destroy cotton-worms.

In dry weather the ground cracks to a great extent. The ants make their nest in these cracks, and while excavating them cover the surface of the ground with fine particles of earth. It is difficult for cotton-worms to crawl over such places; for when they seize hold of the loose particles of earth by their pro-legs, they are unable to balance themselves, roll over upon their sides, and, if the earth be hot, speedily perish. In this indirect way the ants cause the destruction of millions of the worms.

Several of our correspondents stated that ants were known to prey upon the cotton-worm; and Mr. Trelease reported as follows:

> From their great numbers and indefatigable industry, ants are probably among the most important of the enemies of the cotton-caterpillar. Individuals of many species swarm everywhere on the cotton plants, to which they are attracted night and day by *Aphides* and nectar. On many cotton leaves there are places where some larva has eaten the parenchyma of the lower surface, but the most careful search fails to discover the larva. Though not invariably so, these places are often eaten by very young larvae of *Aletia*, and as these are not to be found, it looks as though they had been removed by some enemy, probably ants, though I have never seen ants attack very small caterpillars. In July a number of caterpillars were collected in the bottom-land, to which they were principally confined at that time, and placed on cotton growing in dry, sandy soil, care being taken to see that there were no ants on this cotton when the larva was placed on it, for my insects in breeding-jars in the house had suffered so much from the depredations of ants that I was always afraid of their attacking larvae that I wanted to study in the field; and these particular caterpillars had been removed to the cotton indicated because I wished to make observations on their habits, and wanted them as near the house as might be, while at that time the only larvae to be found in numbers were about a mile from where I was living. Within two hours of the time of placing them on this cotton, each of these larvae was found by several ants, and these soon collected numbers of their fellows, whose combined attacks so worried the larvae that they threw themselves from the plants and were soon killed and carried off by their small but persistent enemies. On several other occasions partly grown caterpillars were killed and carried off in this way by this species and a red ant, yet I never saw ants attack them on the plant excepting when I had thus placed them on ridge-cotton for purposes of study; but when creeping over the ground, as they do after eating up the foliage of the plant on which they were born, if not full grown, hundreds of caterpillars were attacked by these ants and killed. I have never seen more than one species of ant attacking any individual caterpillar, either on the plant or on the ground.

Mr. Trelease further remarks, in speaking of the enemies of the chrysalis:

> In the latter part of July several *Aletia*, just about to pupate, were taken from the swamp where they were found, and with leaves webbed about them they were transferred to cotton on dry soil near the house, where they were tied by their leaves to the petioles of this cotton; my object in placing them there being to determine the length of the pupa state. The same day they shed their last larva-skins and this left them in an almost defenseless condition till the pupa-skin should become firm and tough. About twenty-four hours after this moult they were again visited, and were found covered with red ants, which had killed and partly eaten them all, though they were on different plants, and care was taken to see that there were no ants on the cotton when the larvae were placed there.*

*The ants collected in the cotton fields were referred to the Rev. H. C. McCook, who prepared a report upon them which is embodied in our special report.

PARASITES.

The abundance of the true parasites of the cotton-worm, and the number in which they occur, render their consideration of the highest practical importance.

Taking into consideration the number and variety of these friends of the planter, and the way in which they make themselves obvious to every one who tries to work out the life history of the cotton-worm, it seems very strange that several recent writers should have entirely overlooked their presence. Mr. Grote, in his paper before the American Association for the Advancement of Science, stated that he had never been able to observe any parasites, although he admitted that such might exist; and Professor Riley, in the 1878 circular of this department, states that no enemies of the cotton-worm have hitherto been reported. We mention these two instances in particular, because the undoubted ability of these naturalists renders their statements all the more singular. The fact is that not only were parasites well known to many observers throughout the South, but no less than six accounts had been published with tolerable popular descriptions of *Pimpla conquisitor* (a large ichneumon which extensively infests the last brood of the worms, issuing from the chrysalis in midwinter or early spring), and two very fair figures had also been published.

Let us now enter into a detailed account of these parasites. Up to the time of the present writing thirteen distinct species parasitic upon the cotton-worm, in one or another of its stages, have been bred in the department. Of these, eight species are hymenopterous and five dipterous.

THE COTTON-WORM-EGG PARASITE (*Trichogramma pretiosa*, Riley).—In the latter part of the summer of 1878 a small lot of cotton-worm eggs were received at the department. The eggs were placed in a glass breeding-jar, but much more than the usual time seemed to elapse before the hatching. One morning, however, a number of very minute flies, so small as scarcely to be seen with the naked eye, were found flying around the jar, and the eggs were empty. Here, then, was a true egg-parasite, the mother fly having laid her egg within the egg of the cotton-moth, and her progeny having lived and undergone its transformations within that limited space. Whether more than one parasite issued from a single egg was not determined. These parasites belonged to the great hymenopterous family *Chalcididae*.

The species under consideration is one of remarkable beauty. The general color is yellow, with brilliant red eyes. The wings are very delicate and transparent and present prismatic colors when viewed in different lights. The wings are fringed with excessively fine hairs; their surface is also covered with still finer hairs. In length they are only a trifle more than one-hundredth of an inch (.3^{mm}), but, like all of the subfamily to which they belong, are very active and are great leapers, springing sometimes to a distance of two or three inches.

An allied species (*Trichogramma minuta*) has been reared from the eggs of the dissippus butterfly (*Limenitis dissippus*, Godt.). In this case from four to six individuals have been reared from a single egg of the butterfly, and this seems to be about the normal number. It is probable, then, that more than one parasitic egg is laid within the egg of the cotton-moth. Plate XII, Fig. 14 (*T. minuta*, Riley) will give a very good idea of the general appearance of the magnified insect.*

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*The technical description of *T. pretiosa*, Riley, was published in the *Canadian Entomologist* for September, 1879, and in our special report, p. 194.

With the other twelve parasites the egg is laid in or upon the larva of *Aletia*, and the perfect insect emerges either from the larva or from the pupa. Three of these species belong to the same family as the egg-parasite just mentioned, namely, to the *Chalcididae*.

THE OVATE CHALCIS (*Chalcis ovata*, Say).—This species seems to be one of the most abundant parasites of the cotton-worm in many parts of the South. It is one of the largest of its family, measuring over one-fifth of an inch (5mm) in length. The glassy appearance of its abdomen and its swollen hind thighs give it a characteristic look, and render it impossible to mistake it for any other cotton-worm parasite. From the 4th of August until the 10th of September these little fellows were continually issuing from the chrysalides sent for breeding purposes. There may have been one brood previous, and there probably was one later, the chalcid wintering in the pupa state within the chrysalis of the cotton-worm. The parent fly lays her eggs upon the backs of nearly full-grown cotton-worms, probably more than one egg upon each individual, although we have never observed more than one of these parasites to issue from a single worm. The young larvae feed upon the worm's internal parts, choosing by preference the fatty tissue, and avoiding all vital organs until they become full-grown. During this time the cotton-worm has probably attained its full growth and webbed up. The parasite eats its host out pretty thoroughly before undergoing its own transformations. Both of its changes from larva to pupa and from pupa to fly are undergone within the dead chrysalis of the cotton-worm, and the perfect fly gnaws a round hole near the head of the chrysalis to make its exit. An examination of many chrysalides from which these parasites have issued shows that the hole of exit is invariably near the head, and, upon breaking them open, the abdomen is found to be filled with excrement of the larva, and the cast-off skins of larva and pupa. Plate XII, fig. 13, shows the ovate chalcis enlarged, and also a chrysalis of Aletia pierced by the exit of the parasite.

We can find no published record of the fact of the parasitism of this insect upon the cotton-worm, and are not aware that it was bred prior to 1878.

Cirrospilus esurus, Riley.—Another chalcid parasite (Plate XIII, fig. 1), of much smaller size than the last, was reared in considerable numbers from the chrysalides of the cotton-worm during the summer of 1878. It proved to be a new species of the genus *Cirrospilus*, and has been described under the specific name *esurus* by Professor Riley, in a recent number of the Canadian Entomologist.

It is a little black fly, only about six-hundredths of an inch in length, with yellow legs. From their small size, many of them can find their sustenance in a single cotton-worm, and many of the adults were bred from a single chrysalis.

UNNAMED CHALCID PARASITE.—The following passages from my notes concern a parasite which, owing to a press of other affairs, has not yet been worked up:

August 27.—I found yesterday a cotton-worm about five-eighths of an inch in length which, although yet alive, was being destroyed by three green larvae which were upon it. I found the specimens about 10 a. m. Last evening I observed that the cotton-worm was nearly eaten. The parasites had very short bodies, which when they moved were pointed at one end. I had intended to describe the specimens this morning, but I find they have spun cocoons about their bodies.

August 28.—I found crawling over the ground a small cotton-worm infested by five parasites, evidently of the same species as those mentioned in my note of August 27.

August 29.—The small green parasites which I found yesterday destroyed the cotton-worm, and, excepting two specimens which I put in alcohol, began to spin cocoons during the night.

The insects bred from these specimens were small, black, chalcid flies, shown at Plate XIII, fig. 2. They were nearly eight-hundredths of an inch (2^{mm}) in length. The general color was black, but the legs, antennae, and mouth parts were honey-yellow. The head, thorax, and abdomen were nearly equal in width, and the thorax was longer than the abdomen, which was pedicled and subtruncate at tip. The antennae were 7-jointed.

The larvae were greenish white, oval, somewhat pointed at one end, with yellow spiracles or breathing-holes, and were fleshy and footless. They were sluggish in motion, moving by the alternate contraction and expansion of the segments. The number of segments of the body was plainly thirteen. The full-grown larvae were about 0.08 inch or 2^{mm} in length, and were about half as wide as long. The cocoons which they spun were ovoid in form, grayish-white in color, and about the size of the full-grown larvae.

THE PROCTOTRUPID PARASITE OF THE COTTON-WORM (*Didyctium zigzag*, Riley).—September 16, 1879, a number of small parasitic flies issued from chrysalides of the cotton-worm. Upon examination these proved not to be *Chalcids*, but to belong to the allied family *Proctotrupidae*. The members of this family differ from the *Chalcids* in their usually slender body and longer antennae. The antennae, also, are not elbowed as in *Chalcididae*. It is a family of very minute species, which are all supposed to be parasitic, many of them upon the eggs of other insects.

The species under consideration is shown at Plate XIII, fig. 3. These flies are black, polished, with the antennae and legs dark yellow. The antennae of the female are 13-jointed, the first joint club-shaped, the second almost globular; 3 to 7 are much thinner than any of the others; 3 about as long as 2; 4 to 7 almost globular; 4 a little thinner at base; 8 to 12 about equal in size, round at base, and squarely cut off at apex; 13 as long as preceding, ending in a rounded blunt point. The antennae of the male are very long, about as long as the whole insect. The wings are clear and sparsely beset with short, blackish bristles, and with quite a long fringe around the edge. The veins of the wings are yellowish.

These insects are about .06 of an inch (1.5^{mm}) in length.

These parasites were bred only upon a single occasion. Then many specimens were mounted. Whether they were all from one chrysalis or not it is impossible to say with certainty, but the probabilities are that they were, and it seems probable also that it is not a common parasite.*

The next three parasites which we shall mention belong to the family *Ichneumonidae*, or ichneumon flies, as they are commonly and familiarly called. These insects are characterized by unusually long and slender bodies and the long projecting ovipositors of the females. These ovipositors are often very long, and are protected by a sheath of four stylets of the same length as the true ovipositor. The head is usually rather square, with long many-jointed antennae. The larva is a soft, cylindrical, fleshy, white, footless grub, the rings of the body being convex and the head small. The eggs are laid by the parent either on the outside or within the caterpillar or other larva upon which its young is destined to feed. When hatched, the larva devours the fatty portions of its victim, just as we have seen with foregoing parasites, until it gradually dies. The larva spins a cocoon about itself when about to enter the pupa state. In the larger species this cocoon consists of a dense inner case, and a loose, thin outer covering. Of the larger species but one individual occupies the body of the host, while in the smaller species

* For technical description see special report, p. 197.

many are found within one insect. The cocoons of most species are spun within the body of the parasitized insect; but others, as in the genus *Microgaster*, emerge and spin their small, oval, often bright-colored cocoon s on the outside. The family, as a whole, is one the members o which are of immense service to agriculturists in destroying great numbers of noxious insects.

THE YELLOW-BANDED ICHNEUMON (*Pimpla conquisitor*, Say). (Plate XIII, fig. 5.)—This is one of the most numerous and most noticeable of the parasites of the cotton-worm. It was first scientifically described by Thomas Say, in 1835, who found it in Indiana. He described it under the generic name of *Cryptus*, but it is now considered a *Pimpla* by Mr. Cresson. The yellow-banded ichneumon was bred extensively from the chrysalids of the last brood of cotton-worms, and, so far as we are aware, has never been bred from any preceding brood.

That the earlier broods, if such exist, may be reared in other insects is possible, from the fact that very many members of this family are not confined to one species of insect, and from the fact that Say described the original individuals as from Indiana; and it is probable from their rarity, if not actual absence, among the earlier broods of cotton-worms.

The length of time which it takes one of these parasites to undergo its transformations has not been observed. If the larva spins a cocoon at all, it is very slight; so slight, indeed, that upon breaking off the end of the parsitized chrysalis the pupa of the parasite is exposed to view. The perfect insect emerges in late fall, in midwinter, and in early spring, through an irregular hole which it gnaws through the skin of the chrysalis, usually near the head.

The fact that these parasites are frequently alive within the chrysalides throughout the whole winter has given rise to the supposition on the part of many that the chrysalis itself was still alive, from the motion imparted to it by the contained insect, and have thus been led to believe implicitly in the hibernation of the cotton-worm in the chrysalis state. Many chrysalids were sent to the department during the past winter by persons holding this belief, but, without exception, those specimens which still seemed to have life contained each the pupa of a yellow-banded ichneumon.

The evidence given by Dr. Gorham and Mr. Affleck, as well as our own experience the past year, would seem to show that this parasite is, during certain years, very abundant indeed upon the last brood of worms, and although it might at first be said that the good accomplished by them is smaller than if they were abundant with preceding broods, yet, when we consider that every individual of the last brood which is parasitized reduces by just so much the number of possible hibernators and founders of families the succeeding spring, then we can appreciate the amount of good which this parasite accomplishes, and although we may not indorse the somewhat extravagant estimates of Dr. Gorham and Mr. Affleck, still we may consider ourselves deeply indebted to the yellow-banded ichneumon.

THE RING-LEGGED PIMPLA (*Pimpla annulipes*, Br.). Plate XIII, fig. 4.—September 1, 1879, there issued from a cotton-worm chrysalis one specimen of the ichneumon to which Professor Riley gave the above popular name in his fifth Missouri Entomological Report. This is the only specimen which has been bred this year. It is an old acquaintance, having been bred from the walnut case-bearer (*Acrobasis juglandis*, Le B.) by Dr. Le Baron, and from the codling moth of the apple (*Carpocapsa pomonella*) by Professor Riley. It is a widely distributed species, being found all over the country, north, south, east, and west, and that

it is common is shown from the fact that Professor Riley bred 20 females from a lot of 162 apple-worm cocoons. In these he found great variation in size, some measuring but one-fourth of an inch in length, while others reached one-half.

Roughly describing this parasite, we may say that it presents a nearly black appearance above, the under side of the abdomen being honey-yellow. When viewed with a lens, the upper surface of the abdomen is seen to be covered with close punctures, while the thorax is nearly smooth. The legs are reddish yellow with the exception of the middle joint of the hind pair, which is black, with a broad yellow ring in its middle. The hind feet are dusky. The female ovipositor is dark shining red. The palpi are pale yellow.

CRYPTUS NUNCIUS, Say.—Another ichneumonid parasite, belonging to a different genus from the last two discussed, and known by the above scientific name, was bred from cotton chrysalids, on two occasions or more, in the department last season. It is a very common parasite, and has been often bred in large numbers from the cocoons of the larger Bombycid moths. I have bred no less than 35 individuals from one cocoon of *Telea polyphemus*. It is probable that several may occasionally be bred from one chrysalis of *Aletia*.

This concludes our list of hymenopterous parasites of the cotton-worm. The remaining five belong to the order DIPTERA, or two-winged insects.

The TACHINA FLIES (*Dipt.*, family *Tachinidæ*).—Two of these two-winged parasites belong to the family *Tachinidae*.

These *Tachina* flies have much the appearance of the ordinary house-flies, but are usually larger. Their eggs are tough, white, opaque, oval, and somewhat flattened on the side towards the body, to which they are firmly attached by a gum insoluble in water. With the sluggish caterpillars these flies have little difficulty in depositing their eggs when, how, and where they please. They always place them upon the back of the head, or on the first three or four segments of the body, in such a position, in fact, that the caterpillar can in no way reach them.

The parasitic larva, when ready to hatch, eats its way through the egg on the side towards its victim and burrows into its flesh. They seem endowed by nature with a fondness for nothing but fatty tissue, which teaches them to leave the vital parts of the host alone. When full-bred and ready to transform they do not, as did the last-mentioned parasites, transform within the shell of the insect from which they have obtained their nourishment, but perforate the skin and enter the ground to the depth of from half an inch to two inches. Here they contract to brown oval puparia and remain for a longer or shorter space of time. According to Riley, the last brood usually winters in these puparia. The following spring the fly issuing works its way to the surface of the ground and takes wing.

These insects are among the most effective parasites of many noxious insects. The Northern army-worm is frequently almost exterminated in localities by *Nemoræa leucaniæ*, Kirkp., and *Exorista flavicauda*, Riley.

The Colorado potato-bug has been killed off in great numbers by *Lydella doryphoræ*, a member of this family, and the Rocky Mountain locust found in *Tachina anonyma*, one of its most determined enemies. It would, indeed, have been strange, had not at least one species of this family been found among the cotton-worms.

In November, 1878, two specimens of what seemed to be a new species of *Tachina* were bred from the pupa of the cotton-worm. From these

specimens Professor Riley has described the species, in a recent number of the Canadian Entomologist, as *Tachina aletiae*.

During the season of 1879 many of these parasites have been bred. The latter part of July Mr. Trelease forwarded a quantity of parasitized larvae from Dawson's Station, Ala., with the following note:

JULY 24, 1879.

I mail you to-day a box containing some 95 pupae and webbed-up larvae of *Aletia*. * * * I find nearly one-half of the larvae from one-third to two-thirds grown bearing small white eggs on their backs. (It is only for the last few days that I have noticed this, but it has probably been the case with this entire third brood.) These eggs are of two sizes. The larger are usually, perhaps always, deposited singly on the dorsum of one of the thoracic segments of the larva, and placed transversely or obliquely. They are elongated, oval at the two ends, but more often bluntly rounded. Their length averages about 8^{mm}, their breadth 2^{mm}. They are very slightly flattened on the surface by which they are attached. Sometimes, when no egg can be seen, a discolored mark of the size and shape of the egg is seen on the back of the larva; in other cases a discoloration below the skin of the thorax appears to show the presence of a parasite larva. The smaller eggs are also white, and measure about 6^{mm} by 2^{mm}, from which you will see that they are broader proportionally, and consequently more oval than cylindrical. They are slightly more flattened on the under surface as a rule. These are deposited on the side and back of the head and thoracic segments, and vary, in the cases so far noticed, from one to four in number; sometimes, where there are several, being scattered almost in contact with each other.

These eggs were fastened very firmly to the back of the larvae, and were all so placed that the victim could by no exertion reach them with its jaws. In some cases they appeared to be even sunk beneath the skin, and Mr. Trelease records the fact in a later letter that he has seen the skin shed without the egg being also cast off. The adult flies, from these specimens sent July 24, began to issue September 1. This, taken in connection with the fact that the specimens reared in 1878 issued in November, would seem to argue three broods a year for this species of *Tachina*, the last two broods certainly destroying many cotton-worms.

An examination of the specimens issuing from this lot of worms revealed two individuals of a new species of *Tachina*, differing from *T. aletiae* in several respects. We draw up the following description:

Tachina fraterna, n. sp.—Length 6^{mm}.

Color.—General effect nearly black; head, face, and facial depression silvery white, inclining slightly to golden on occiput; antennae, 1st and 3d joints black, 2d joint testaceous: palpi testaceous; pubescence behind the head blackish; thorax, second and following abdominal joints ashy; thorax with two plain longitudinal black stripes and two indistinct; first abdominal joint black above, ashy beneath; femora piceous; tibiae and tarsi nearly black. Eyes finely pubescent. In other respects resembling *T. aletiae*, Riley. Described from two specimens.

FLESH-FLIES (*Dipt.*, family SARCOPHAGIDAE, genus *Sarcophaga*).—From general appearance it would be impossible to separate a flesh-fly from a *Tachina* fly, and only by the help of a lens is it possible to distinguish them; the principal difference being that in the family now under consideration the style of the antennæ or antennal bristle is plumose or hairy, although naked at the tip, while in *Tachinidae* it is naked throughout its length. These flies have long been considered remarkable on account of their viviparous habits. The eggs are long and delicate and hatch quickly. If the female is unable to find a suitable place to deposit them within a given time after fertilization they hatch within her body, and we have the phenomenon of a viviparous insect. The ovaries are large and arranged in a spiral manner, and De Greer is said to vouch for the development of 20,000 larvae in one female. The dis-

tinction between the earlier forms of the flesh-flies and *Tachina* flies is said by Professor Riley to be that—

> The *Tachina* larva is rounded posteriorly, with a small spiracular cavity, easily closed, and having a smooth rim; it contracts to a pupa, which is quite uniformly rounded at each end. The *Sarcophaga* larva is more truncate behind, with fleshy warts on the rim of the spiracular cavity, and with a more tapering head; it contracts, a pupa, which is also truncate behind and more tapering in front, where the prothoracic spiracles show, as they never do in *Tachina*.

It is the general habit of the flesh-flies to deposit their eggs or young upon dead and putrefying animal matter, but they are often known to thus infest living animals, thus partaking of the nature of parasites. Their habits are then similar to the *Tachinidae*. The larva lives within the insect, and similarly issues when full grown to pupate under ground.

During the summer of 1878 several specimens of a flesh-fly were reared from pupae of *Aletia*. These proved to be specimens of *Sarcophaga sarraceniae*, Riley, a probable American variety of that widespread scavenger *Sarcophaga carnaria* (Plate XIII, fig. 6), Linn., a species common to Europe, America, and Australia certainly, and probably elsewhere to be found.* *Sarraceniae* was first described by Professor Riley, in a paper read before the Saint Louis Academy of Sciences, as feeding upon the dead insects to be found in the leaves of *Sarracenia*. Plate XIV, fig. 1, represents this insect in its various stages.

Several specimens of *sarraceniae* have been secured the present summer (1879), and also what may prove to be a new species of *Sarcophaga*.

Plate XIV, Fig. 2, represents the insect in all stages; *a* is the egg, natural size; *b* is the egg enlarged; *c* is the full grown larva; *d* is the head of the larva enlarged; *e* is the puparium; and *f* the adult insect.

PHORA ALETIAE, Comstock.†—August 12, 1879, a large number of small white maggots were found in chrysalides sent from Minters, Ala. These maggots, which appeared nearly full grown, were about 0.15 inch (4^{mm}) in length; they were rather slender, the 9th segment being the broadest. The posterior end of the body was large and rounded, and the anterior end tapered gradually to a point.

Examination with a lens showed that each segment was armed laterally with four short, stout spines (two on each side), and the posterior end of the body was furnished with six. August 16 these larvae commenced to pupate. The puparium was light brown in color, 1^{mm} by 2^{mm} in size. The front side showed the joining of the segments, and was somewhat rugose; the back side was smooth; the posterior end was rounded and armed with the same six small spines that were present in the larva; the anterior end of the body was more pointed. From about the third thoracic segment two long black excurved spines protruded, which presented the most characteristic feature of the puparium. The perfect flies began to issue in great numbers August 27, or about ten days from the time of commencing to pupate. They proved to be active little yellowish-brown two-winged flies, with robust bodies and short, stout wings. They are well represented at Plate XIV, Fig. 3, as also are the larva and pupa.

From present indications, this insect bids fair to be one of the most important, as it is one of the most interesting, of the parasites of the cotton-worm.

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*I am in receipt of a communication from Baron Osten-Sacken, commenting upon the above, in which he says: "Allow me to observe, in this connection, that *Sarcophaga carnaria* does *not* occur in North America. You will find that statement, with some detail, in my recent Catalogue of the described North American Diptera, p. 158."

†For technical description see special report, pp. 209–211.

IMPORTANCE OF THE NATURAL ENEMIES OF THE COTTON-WORM—SUMMARY.

From a perusal of this section it is doubtful if the reader has obtained a very definite idea of the actual amount of good performed by the natural enemies of the cotton-worm, except that it is by no means insignificant. It would, indeed, be a difficult task to estimate the number of cotton-worms, in one stage or another, that are destroyed every year by the different birds and insects; but we will bring together in this summary such points as relate to the amount of good performed, hoping to set the importance of the subject forth in a more definite light.

Among the vertebrate enemies, it will be of interest in this connection to be able to form an idea of the *actual number* of insects destroyed by the average insectivorous bird. As concise a statement of facts upon this point as we have met with is given in Professor Aughey's report to the United States Entomological Commission. Professor Aughey says:*

Few unobservant people have any comprehension of the vast number of insects that birds actually destroy. During the breeding-season this destruction of insects by birds reached its culmination. The young of some species will eat about 50, others about 60, some about 75 insects each day. The average cannot be far from 60. At this rate five young birds would eat about 300 insects each day, or about 9,000 a month for each month, exclusive of the parents. There have been widely different estimates as to the number of insects that the old birds eat, but it ought not to be difficult to approximate the quantity. Only a small part of a bird's stomach is entire enough to be distinguished and counted. If the balance is composed as largely of insects, which is more than probable, then the whole number eaten during a day by an insectivorous bird must be near 200. I reached the same conclusion by actual tests. In the fall of 1874 I bought two Bastramian plovers from some boys who had trapped them, and kept them for a week in a cage before they were set free. I fed them on locusts and other insects, which I counted for four days with the following result:

First day	277
Second day	452
Third day	448
Fourth day	439
Total	1,616
Average per day	404
Average for each	202

I was compelled to go away or else the experiment would have been continued longer.

About one-fourth of the insects were locusts, and the balance were flies, ants, beetles, &c. I gave them whatever insects the boys that I hired gathered for me. My impression, however, is that they ate less than they would have done if they had been at liberty. But, lest there might be some mistake, and to avoid all possibility of error on the wrong side, we will base our calculations on an estimate of 150 insects each day for a mature plover. At this rate 20 old plovers would eat 3,000 insects each day, or 90,000 a month. And suppose further that these 20 plovers had nests which averaged four young ones each. At 60 insects a day for each young plover the 40 would consume 2,400 every twenty-four hours, or 72,000 a month. The 20 plovers and their progeny together would consume 162,000 insects each month. At this same rate 1,000 plovers and their young would consume in one month 8,100,000 insects. That many insects removed in one year from a farm of 160 acres would probably render it capable of producing crops even when these insects were doing their worst. As there are many birds that eat more insects than do the plovers, as well as many that eat less, 150 insects a day is probably a fair average for all insectivorous birds.

This extract is eloquent as a defense of birds, and puts us on a sound basis of apparently unexaggerated facts. Too much, then, can hardly be said in favor of insectivorous birds in cotton-fields.

With the exception of the ants, predaceous insects are hardly to be

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* First annual report of the United States Entomological Commission, 1877. Rocky Mountain Locust, Department Interior, 1878.

compared either to the birds or to the parasitic insects in regard to the number of cotton-worms which they destroy. True, the capacity of some of them is great, but they either labor under disadvantages (such as being comparatively confined to the ground as the carabid beetles) or are not sufficiently numerous to do a very great amount of good. Still it is well to know them and not destroy them, as thousands of worms are destroyed by them, and it is only in a comparative way that we speak at all deprecatingly of them. The capacity of the rear-horses (*Mantis carolina*) has been shown by the statement that one individual has in one night killed and devoured eleven Colorado potato-beetles, and we have mentioned the fact that a young specimen of the wheel-bug (*Prionotus cristatus* [*Reduvius novenarius*]) has been known to destroy ten caterpillars in five hours, thus showing the amount of good which may be done by the hemipterous enemies of the cotton-worm. The destructive powers of the asilus flies have been shown from Mr. Thompson's statement that he has known one individual to destroy 141 bees in a day. The work of ants in this direction has been discussed at length, and they are shown to be the most valuable of the predaceous insect enemies of the cotton-worm.

The destruction of the cotton-worms by their true parasites is a subject upon which interesting experiments may be made. The extent of parasitism will undoubtedly vary much with the season of the year, the last brood always seeming to be much more extensively parasitized than any of the preceding broods. The probabilities are that they increase with the increasing numbers of the worms, and that they also are affected to a certain extent by the character of the season, although not comparably with the ants. From August 12 to August 28, 1,721 pupae probably belonging to the fourth brood were received at the department from Alabama, for the purpose of ascertaining the extent of the parisitism. The result hardly justified the anticipation. From this lot of 1,721 chrysalides there issued in all 1,455 moths, and from the remaining 266 chrysalides were bred the following parasites: Of *Chalcis ovata*, Say, 32 specimens; of *Tachina aletiae*, Riley, 3 specimens; of *Sarcophaga* sp., 7 specimens; of *Pimpla annulipes*, Br., 1 specimen; of *Tachina fraterna*, 2 specimens; of *Didictum zigzag* sp., 32 specimens; of the small Dipteron *Phora aletiae*, a very great number of specimens; making altogether of the large parasites, 44, each singly from a chrysalis, and 120 chrysalides destroyed by the small parasites, making a total of 164 out of 1,721, or between 9 and 10 per cent. The remaining 102 died from some unknown cause. This percentage is small, but in the last brood it would undoubtedly be greater.

The extravagant ideas of Dr. Gorham on the subject of the extent of parasitism are easily accounted for. He collected his specimen chrysalides for observation late in the fall, after the hibernating moths had issued. Naturally, no apparently sound chrysalides were left excepting those containing parasites. These he collected, and parasites issued from all; hence his conclusions. A note from one of Professor Willet's letters seems to indicate the greater abundance of parasites in the last brood than in the earlier ones. He collected a number of newly-formed chrysalides in November. Of these he says:

About two dozen were placed in a box in my sitting-room, expecting to hatch out some moths for exposure. The following is the result: In some two weeks two moths came out; they seemed delicate, and one lived only two days, the other four or five. No other moths have appeared (December 11). November 24, I found four ichneumon flies (*Pimpla conquisitor*) out in one boll; December 2, one more; and December 7, another; the sixth, the last, with no ovipositor (a male). In breaking open the dried chrysalides I destroyed two pupae of parasites. These make eight parasites in some

two dozen chrysalides—a large proportion. I had 75 chrysalides in a box in summer; about 50 came out moths; most of the others could not escape from and perished in the dried leaves. I saw not a parasite of any kind.

An encouraging statement concerning the extensive parasitism of an early brood (the third) is contained in a letter from Mr. Trelease of July 24, 1879. He stated that at that time *nearly one-half* of the half-grown worms in the fields under his observation bore the eggs of one of the *Tachina* parasites. One-half is certainly a large proportion, but he reiterates it with exactness in his notes, and stands ready to vouch for it. It seems not at all unlikely when we consider the numbers in which the northern species of *Tachina* occur in fields ravaged by the northern army-worm. In a field which was black with these worms I have searched for hours without finding a single unparasitized full-grown worm. Nine hundred and ninety-nine out of a thousand bore the white eggs of the destroyer.

These few points will be sufficient to give a more accurate idea of the importance of the natural enemies of the cotton-worm.

REMEDIES.

PREVENTIVE MEASURES.—The most important of the preventive measures which can be adopted is the encouragement of the natural enemies of the cotton-worm. Detailed accounts of these have been given in a previous section; hence, but little remains to be said here.

The most practicable thing which can be done in this direction is the protection by law of all the native insectivorous birds. An incalculable amount of injury has been done by the indiscriminate destruction of birds by the freedmen since the close of the war. In addition to the protection of the native species, others might be introduced. But here very great care must be exercised, else more harm than good may be accomplished. No species should be introduced *the habits of which are not thoroughly understood.* We wish to call particular attention to this point, as many planters have urged us to aid in the introduction into the cotton States of the English sparrow, a species the importation of which into the Northern States has been pronounced a calamity by nearly all of the American ornithologists.

The encouragement of the insect enemies of the cotton-worm, though less practicable than the protection of birds, is not less important; for this reason, great care has been taken to figure and describe all the predaceous or parasitic insects which destroy the cotton-worm. It would be worth the while of every planter to become familiar with the appearance of the more common of these, and instruct his hands not to injure them. In those cases in which hand-picking of the pupae of *Aletia* is employed, much good can be done by taking care not to destroy the parasites contained in them. The pupae, when collected, instead of being destroyed should be placed in barrels or boxes covered with coarse wire gauze or other netting. In this way the parasites which emerge from the pupae can be allowed to escape through the meshes of the netting, and are thus enabled to go on with their destruction of the pest; whereas the moths which mature, being larger, cannot escape, and perish in their prison. Some idea of the importance of this precaution may be gathered from the results of an experiment already cited, in which it was found that of 1,721 pupae of the fourth brood, nearly 10 per cent. were parasitized. Or what is more to our purpose, there were bred from these pupae 44 large parasites (*Pimpla*, *Chalcis*, and *Tachina*), and an immense number of small parasitic flies belonging to the genus *Phora*. It must be remembered that the later broods of *Aletia* contain a larger percentage of parasitized individuals.

Under this head will come also the suggestion of Mr. Nicholas A. Davis, of Jacksonville, Tex., who recommends planters to avoid plowing cotton-fields when they are wet for fear of destroying ants, and also advises planters not to plant cotton on wet land where ants do not live.

As another preventive measure, would it not be well to plant less cotton and cultivate more thoroughly, using fertilizers? In this way more cotton would be made early in the season, before the worms increase sufficiently to injure it, and then, with smaller fields to go over, the force upon a plantation would be sufficient to apply remedies in season to keep the worms in check.

With a view to rendering the cotton distasteful to the caterpillar, if possible, quassia chips were steeped and soaked in water for about a week and a half, one pound of chips being used for each gallon of water. This decoction was then diluted, from a pint to a quart of it being added to each bucketful of water (2 gallons), and applied with a fountain pump to infested cotton, so that every leaf was thoroughly wet. In this form the infusion was intensely bitter and imparted a strong taste to the cotton leaves after the water had evaporated; but though several applications were made it did not interfere with the feeding of the worms.

DESTRUCTION OF EGGS.—Many attempts have been made to destroy the cotton-worm in the egg state. These have been accompanied with but little success. Owing to the fact that the tender terminal leaves are first destroyed by the worms, planters have believed the eggs were laid upon this part of the plant. This belief has suggested the idea that by cutting off and destroying the terminal shoots the eggs would be removed. But as shown in the chapter on natural history, the greater part of the eggs is laid on the lower surface of the larger leaves of the middle third of the plant; hence by topping the cotton only those worms which happen to be on that part of the plant would be destroyed.

Owing to their small size, and the position in which the eggs are deposited, any attempt to destroy the insect in this state will prove impracticable. And the destruction of the few larvae which are removed with the terminal shoots does not pay for the labor of topping the cotton, especially as the entire cotton can be poisoned with less labor.

COLLECTING LARVAE BY HAND.—Although it may seem a hopeless task to preserve a field of cotton by collecting the larvae by hand, we feel that very much can be done in this way if the effort is made at the proper season. It would be a waste of labor to attempt to destroy in this way the individuals of the third crop of worms. Not so, however, in case of the first brood. This appears in such small numbers that by careful searching a very large proportion of them could be found. This, of course, would materially lessen the numbers of the subsequent broods. As early as the middle of May the cotton fields should be thoroughly searched: at this time the cotton plants are small, therefore, this could be done with comparatively little labor. Much could be accomplished by instructing the hands to carefully collect all larvae and folded leaves containing pupae found while working the cotton early in the season. We believe, however, that instructions of this kind could only be made to produce the maximum results by offering a reward for every specimen captured before a certain date, say June 1; a smaller reward might then be offered for each specimen between that time and some subsequent date. We have no doubt that were each planter to expend a small sum in this way greater returns would be realized than could be obtained by the expenditure upon the crop of a like sum any other way. And we are inclined to believe that even in case where

concerted action cannot be obtained good results will follow individual efforts. For, although the summer and autumn broods of moths migrate to great distances, there is reason to believe that the hibernating individuals and those of the early broods do not do so to any great extent. As evidence of this we cite the fact that considerable time elapses between the appearance of the worms in those localities which we have designated as centers of hibernation and in the more northern parts of the cotton belt.

DESTRUCTION OF LARVAE BY POISONS.—In the present state of our knowledge it seems that the most effectual means of destroying the cotton-worm is by the use of poisons, either in the moist or dry condition. In the former case, the poisonous substance is dissolved or suspended in water; in the latter, it is mixed with flour, gypsum, or other innocuous powder, which serve to dilute it, and in some cases to aid it in adhering to the plant.

During the season of 1879 a careful and extended series of experiments were conducted by Mr. William Trelease, under my direction, for the purpose of ascertaining the best poison for use, taking into consideration both its efficacy as an insecticide and its effect on the plant. Special attention was also given to ascertaining the most rapid and economical method of applying poisons.

These experiments were performed under especially favorable conditions. Mr. Trelease was located upon a plantation in the southern part of Dallas County, Alabama, a locality in which cotton-worms are especially destructive; he made arrangements by which he could call into service all the help on the place if necessary. In this way he was able to use the remedies on a large scale, and to carefully compare the results obtained by different methods. A neighboring plantation upon which no efforts were made to protect the cotton served also for comparison.

As we shall have occasion to refer to these experiments we give here a part of Mr. Trelease's report relating to them.

The ground covered by my experiments with poisons may be seen from the following tables:

I.—TO TEST THE EFFICACY OF THE SUBSTANCES.

A.—Wet.
- (*a*) London purple, suspended in water.
- (*b*) Gray arsenic, suspended in water.
- (*c*) Paris green, suspended in water.
- (*d*) Texas worm-destroyer, dissolved in water.
- (*e*) Gray arsenic, in Fowler's solution.
- (*f*) Oil of turpentine, in water.
- (*g*) Kerosene, in water.
- (*h*) Carbolic acid, in water.

B.—Dry.
- (*a*) London purple, in Royall's mixture.*
- (*b*) Gray arsenic, in Royall's mixture.
- (*c*) Paris green, in Royall's mixture.

II.—TO TEST THE ADHESION OF THE SUBSTANCES.

A.—Wet.
- (*a*) Poisons suspended in water without flour-paste.
- (*b*) Poisons suspended in water with flour-paste.

B.—Dry.
- (*a*) Poisons mixed with flour.
- (*b*) Poisons mixed with flour and gypsum.
- (*c*) Poisons mixed with flour and rosin.
- (*d*) Poisons mixed with flour and dextrine.
- (*e*) Poisons mixed with flour, rosin, and dextrine. †

*Royall's patent: Flour, one barrel, 196 pounds; Paris green, 9 pounds; dextrine, 10 pounds; rosin, 12 pounds.
The ingredients being in a fine powder, are sifted to remove lumps, after which they are thoroughly mixed. Other poisons may be substituted for Paris green.

†*Ibid.*

B.—Dry.
- (*f*) Poisons mixed with flour, gypsum, and rosin.
- (*g*) Poisons mixed with flour, gypsum, and dextrine.
- (*h*) Poisons mixed with flour, gypsum, rosin, and dextrine.
- (*i*) Poisons mixed with gypsum, rosin, and dextrine.
- (*k*) Poisons mixed with gypsum and rosin.
- (*l*) Poisons mixed with gypsum and dextrine.
- (*m*) Poisons mixed with gypsum.

All of my wet poisons were applied by use of Whitman's fountain-pump No. 2. Where small quantities were used, one man carried a 2-gallon water-bucket, and another preceded him, working the pump. Where larger quantities were used, a 40-gallon barrel was placed in a four-wheeled wagon, with wheels 5 feet apart and the lowest axle 23 inches from the ground. This was drawn by two mules, being made to straddle one row of cotton, the mules walking in the furrows that the wheels ran in. One man drove the wagon, and two others, provided with fountain-pumps, distributed the poison contained in the barrel, wetting nine rows for each trip across the field. Meantime, one or two other men, with a two-horse wagon containing several smaller barrels, were engaged in carrying water from a pond to the ends of the rows of cotton, where it was transferred to the distributing wagon. With these two pumps worked slowly, the mules walking very slowly, we found that a barrel of water went over about three acres of cotton, wetting it fairly, but not so well as was to be desired. The men were therefore made to work the pumps faster, so that a barrel lasted for two acres. Not satisfied with this, we enlarged the holes in the rose-nozzle a little, so that without materially diminishing the force of the pump we were able to apply a barrel of fluid to the acre.* In this way about 30 acres a day may be poisoned by four hands and four mules.

My dry poisons were applied by a sieve made of a 2-quart tin bucket, the bottom of which was replaced by perforated tin, and which was provided with a socket at the side for the insertion of a wooden handle about three feet long.

My experiments with dry poisons were not extensive enough for me to determine accurately the amount of labor required to poison an acre; but Mr. Lide, the manager of George O. Baker's plantation at Selma, Ala., tells me that a hand can poison from one to two acres of cotton per day. He tells me, further, that one barrel of Royall's mixture goes over about three acres.

Before giving details of the experiments, I may briefly state the conclusions to which they led me, as follows: As an insecticide I prefer Paris green to any other substance used, and find it less likely to injure the cotton than any other. Next to this I should place commercial arsenic (arsenious oxide, As_2O_3), though this is more likely to scorch the cotton than the preceding. I should place London purple next in the list, as being less valuable as a poison and more liable to injure the cotton. Fowler's solution of arsenic (arsenious oxide dissolved in a solution of sodium or potassium carbonate in water) serves fairly as an insecticide, but my experience is that it is very liable to injure the cotton, probably owing to the alkaline nature of the solution. A considerable quantity of the mixture known as the Texas Cotton-Worm Destroyer was used, the directions accompanying the package being followed; but I failed to obtain satisfactory results from its use in any trial. Oil of turpentine, kerosene, and carbolic acid in water were applied, but when applied so as to kill the caterpillars I found that they always injured the plant.

The cheapest mode of applying the poisons is undoubtedly in the wet form; and I find that they adhere as well when suspended in pure water as when paste is used, though this aids in their suspension. Whenever a solid is used in suspension, frequent stirring is needed to keep it evenly distributed through the water. In Royall's patent the flour is supposed to act as a diluent; the rosin, to melt by the heat of the sun and thus affix the poison to the leaves of the plant; the dextrine, to melt and gum the poison to the leaves under the action of water, either as dew or rain. My experiments showed me that flour alone adhered nearly as long as this mixture; and even that it might be replaced in part by gypsum or land plaster, but that gypsum alone, or replacing all of the flour in Royall's patent, was removed by the first rain as a general thing. The reason for this is that the first dew converts the flour into a paste, which becomes attached to the leaf, and considerable rain is needed to dissolve and remove it. I find that one pound of Paris green, applied in forty gallons of water to an acre of cotton, will kill the worms to a certainty without injuring the cotton to any appreciable extent, provided there is no rain on it for several days; but the dry prison, using about twice as much Paris green to the acre, is equally certain and safe, and will withstand far more rain, even if merely mixed with flour. Owing to the cost of the flour, however, and the greater cost of applying it, the dry poison is far more expensive than the wet.

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*It is far better to employ the larger size of pump, which, from its greater capacity, distributes more water than the one used by me, and with less labor.

A.—WET POISONS.

August 7, nine barrels of water were applied, going over about three acres to the barrel. The time spent was from 9 a. m. to sunset, and the first rain fell at about nine o'clock the next morning. The substances used, their quantities, and the number of dead worms just before the rain began are shown by the following table:

I.—*Wet poisons applied August* 7, 1879.

Number of barrels.	Name of poison.	Quantity of poison.	Quantity of paste.	Dead worms.
1	Texas worm-destroyer	Measure		None.
2	London purple	16 ounces	1 gallon	Very few.
3	Gray arsenic	21 ounces	1 gallon	Do.
4	Paris green	21 ounces	1 gallon	Few.
5	London purple	20 ounces	1 gallon	Very few.
6	Paris green	16 ounces	1 gallon	Do.
7	Gray arsenic	20 ounces	1½ gallons	Do.
8	Texas worm-destroyer	1 measure		Very few or none.
9	do	1 measure		Do.

Rains occurred nearly every day for about a week after this was applied. On the 9th of August I found no dead worms, and examination with a lens showed very little poison on the leaves; nor was the cotton scorched except in one or two places where the poison was a little thicker than usual; but vines of the cow-pea growing in the field were considerably injured. The caterpillars continuing to eat, we again poisoned this cotton on the 11th, 12th, and 13th of August.

In the following table the quantity of poison per barrel of water is given, but in some sections several barrels were used:

Date.	Section.	Name of poison.	Quantity of poison per barrel.	Quantity of paste per barrel.*	Length of time before rain.	Dead worms after 24 hours.
1879.						
Aug. 11	10	Paris green	24 ounces	2 gallons	54 hours average	A fair number.
	11	London purple	16 ounces	2 gallons		Some.
	12	Gray arsenic	20 ounces	2 gallons		Few.
Aug. 12	13	Paris green	24 ounces	2 gallons	30 hours average	Many.
Aug. 13	14	Texas worm-destroyer	1 measure		12 hours average	Scarcely any.

* In all of my experiments where paste was used it was made by boiling wheat-flour in water, so as to be a trifle thicker than the starch commonly used for stiffening linen articles. Some farmers, to avoid the labor of boiling the paste, allow flour to ferment in water, obtaining a very good article in this way. In either case it should be strained through muslin. Mr. Patrick Calahan, of Selma, merely stirs two pounds of common starch in a bucketful of cold water, which is then added to 40 gallons of water containing the poison.

When applying the poisons to sections 10 to 14, inclusive, we used two mules to draw the distributing wagon, in which were the driver and two hands with pumps. Another hand, with a two-mule wagon, was engaged in drawing water from a pond to the ends of the cotton rows, where it was transferred to the other wagon. Owing to the low specific gravity of London purple, the bulk of a pound of it is far greater than that of an equal bulk of arsenic or Paris green, and the hands complained that it pumped out harder than either of the other poisons named. Certain it is, that, other conditions being about the same, a barrel went over three acres in section 11, while in 12, 13, and 14 it went over only two. On section 10 the pumps were worked less rapidly, so that a barrel of water went over three acres. Twenty-four hours after each section was poisoned I examined it to see what effect the poison had produced on the worms and cotton, and leaves plucked here and there were examined with a lens to discover how thoroughly the finely divided poison was applied. There was a considerable number of worms dead on section 10, and most of the others died before the first rainfall. The Paris green could be seen in very fine particles in the minute hollows everywhere on the surface of the leaf. The cotton plant was not in the least injured. On section 11 the percentage of dead worms after twenty-four hours was considerably less than on 10, but before the rain fell the greater part of the others were dead. The poison appeared as a fine purple bloom on the surface of the leaf, and in a good many

places the leaves were scorched seriously. The arsenic used on section 12 did not scorch the cotton, nor did it kill many worms at first, but later it destroyed a good number. By far the best results were obtained on section 13, where the worms were quickly and thoroughly killed, and only at long intervals could a scorched leaf be found. Though the Texas worm-destroyer used on section 14 was applied according to directions, it being stated that more than one measure, about 4½ ounces to the barrel of water, would injure the cotton, it killed remarkably few caterpillers.

A light but steady rain fell all of the night following August 13, continuing through the next day and night and a part of the 15th. An examination of the cotton after this rain showed that little poison was then adhering to the leaves. In all of my experiments I found that full-grown caterpillars never ate the poison, but webbed up immediately after it was applied. These excepted, there were few living worms on any of these sections excepting 14 where I could not see that the poison had done any good. On the 21st of August most of the foliage had been eaten from this section, while little was removed from the adjoining section 13. When I compared section 12 with the unpoisoned cotton on a neighboring plantation—from which it was separated only by a ditch—at this latter date I could see that the arsenic had done good, for the cotton was not nearly so badly eaten where the poison was used as just across the ditch, and at the time of poisoning it was infested worse than the other.

Much of this cotton was as high as the top of the wagon-box, and there was none that was not bent as the axle passed over it; yet I found that very little damage was done by driving down the rows, though occasionally bolls were jolted off and now and then the driver ran the wheels on a row so as to injure it, but this was the result of carelessness. Unless cotton is very high and closely interlocked between the rows I should not hesitate to drive a large-wheel wagon over it if necessary in poisoning.

August 29 five sections were poisoned, as shown in the following table. But one pump was used, the nozzle of which had been reamed so as to discharge a larger quantity of water for a given expenditure of labor. With this we were able to distribute 40 gallons of water per acre. As before, one man drove and another hauled water to the side of the field.

Date.	Section.	Name of poison.	Quantity of poison per barrel.	Quantity of paste per barrel.	Length of time before rain.	Dead worms after a week.
Aug. 29, 1879	15	Arsenic	16 ounces	4 gallons	48 hours	Few.
	16	Fowler's solution*	3 quarts			Scarce any.
	17	London purple	16 ounces	4 gallons		Few.
	18	Texas worm destroyer	1 measure			Scarce any.
	19	London purple	8 ounces	2 gallons		Very few.

* As_2O_3, 384 grains. K_2CO_3, 384 grains. H_2O, 3 quarts.

In preparing Fowler's solution on a large scale the potassium carbonate may be replaced by the much cheaper sal-soda. As recommended by Capt. N. D. Cross, of Selma, sal-soda and gray arsenic are taken in equal proportions by weight; the soda is dissolved in a little boiling water, the arsenic is then added, and, when dissolved, water is added in such quantity as to make one gallon of the solution for each ounce of arsenic used. He recommends the use of 1–1½ gallons of this normal solution for each barrel of water.

With our single pump we were able to cover only five rows of cotton for each trip across the field and do it well. Including the time spent in filling the barrel, it took 45 minutes for each barrel of poison put out; or, in ten hours, three hands and four mules would poison about 13 acres.

On the 1st of September a light rain in the early afternoon became heavier about 4 p. m. and lasted till some time in the night, a few drizzling showers having fallen the day before.

When these poisons were applied there were scarcely any worms on the cotton poisoned, but many eggs. On the 4th of September I noted that these had hatched, but few larvae had yet eaten through the leaves so as to reach such poison as the rains had left. Of the few worms on the cotton before the rain I had noticed a small number of dead ones, the most being found on section 17, the next on 15, the next on 16, but neither 18 nor 19 did much good. Coming as they did, the rains removed the greater part of the poison before the young worms could eat it, so that little good was done by this poisoning.

September 5 some cotton badly infested with newly-hatched caterpillars was poisoned, as follows:

Date.	Section.	Name of poison.	Quantity of poison per barrel.	Quantity of paste per barrel.	Length of time before rain.	Dead worms after 48 hours.
Sept. 5, 1879..	20	Paris green	24 ounces .	3 gallons ..	8 days	Many.
	21	......do	16 ounces .	....		Do.
	22	......do	24 ounces .	....		Do.
	23	Kerosene	10 fl. ozs ..	....		Few.
	24	Turpentine	20 fl. ozs ..	....		Do.

In all we poisoned a little less that three acres this time, using only about half a barrel on section 22. One hand worked the pump, wetting six rows at a time; another followed him with the bucket of poison. Previously I had caused a barrel in the middle of the field to be filled with water. In this I suspended the poison, having the men replenish it as often as necessary. About four gallons each of the kerosene and turpentine mixtures were used.

The next day, when I examined the Paris-green sections, I found many worms dead on each of them. When I rubbed the leaves with my hand, or sprinkled water over them, I could not see but that one adhered as well as another. Here and there a leaf was badly scorched, and some few forms were injured; but, taken as a whole, the field suffered little. Here I noticed what was also seen before and afterward, namely, that a leaf may be completely covered with Paris-green sediment and yet show no scorching; but where the dead spots appear on the leaves there may be little of the poison. Paris-green being practically insoluble in water, I am unable to account for this.

On the 8th of September I noted that the cotton on which Paris green was used three days before was uninjured by the worms, though a few were still eating, most of these having hatched after the poison was applied. But where I used kerosene or oil of turpentine the cotton was almost leafless, these substances having injured some of the leaves and killed a considerable number of larvae, but not enough to save the crop.

September 10, a number of gallons of water, containing from a half teaspoonful to a teaspoonful of carbolic acid per gallon, were applied with the fountain pump. This water was stirred so that the acid was suspended through it as *very* small globules. It was found to kill some caterpillars, but by no means enough to save the cotton; and, used in these proportions, it injured the cotton considerably. More water, containing kerosene and oil of turpentine in varying quantities, was applied; but, like the last, I found that it did not effectually destroy the worms, even when strong enough to seriously injure the cotton.

B.—DRY POISON.

In the afternoon of August 22 I poisoned four sections with dry poisons, as shown in the annexed table. Where flour was used with either rosin or dextrine, or both, the proportion was that used in Royall's patent. Where gypsum was used, it replaced the flour, bulk for bulk, in this series.

Date.	Section.	Name of poison.	Substances mixed with.	Length of time before rain.	Effect as an insecticide.	Quantity adhering after rains.
Aug. 22, 1879	1	London purple	Flour .... Dextrine. Rosin	0 hours ..	Fair	Fair quantity.
	2	Paris green	Flour .... Dextrine. Rosin		Good ...	Do.
	3	London purple	Flour		Fair	Do.
	4	Paris green	Gypsum		Good ...	Very little.

As will be seen from examining this table, a rain began falling before we had finished applying the poisons. This rain continued to fall all night, all of the next day, and part of the succeeding night. Another heavy rain occurred the next night. On the 26th I found that the cotton of sections 1 and 3 was scorched considerably, far more than either 2 or 4. The second section had killed the most worms. I could not see but what section 3 adhered as well as either 1 or 2, and all were far better than 4.

August 26 four additional sections were poisoned; the only variation from Royall's mixture being in omitting some ingredient, substituting gypsum, bulk for bulk, for flour, or varying the quantity of poison.

Date.	Section.	Name of poison.	Substances mixed with.	Weight of poison per barrel, flour.	Length of time before rain.	Effect as an insecticide.	Quantity adhering after rains.
Aug. 26, 1879	5	Arsenic	Flour, Dextrine, Rosin	12.5 pounds	120 hours	Good	Much.
	6	Paris green	Flour, Dextrine, Rosin	9.0 pounds		do	Do.
	7	London purple	Plaster, Dextrine, Rosin	12.5 pounds		do	Little.
	8	Paris green	Flour	9.0 pounds		do	Much.

When these poisons were applied in the afternoon the sun was shining brightly. The mixture with plaster was scattered more easily than those with flour, and distributed itself very evenly over the leaves. On the 31st of August a few drizzling showers fell, and there were more on the next day, scarcely any falling during the succeeding night, and a very little the following morning. August 28, after two clear days and dewey nights, I found all of these poisons adhering well; though the flour, by forming a sort of paste, had collected into blotches, while the plaster remained as evenly distributed over the leaf as ever. On the 2d of September I noted that the cotton of section 5 was somewhat scorched. Section 6 was scorched very little. Though section 7 was in great part removed, it had scorched the cotton considerably; more than either of the other sections. Very few leaves were injured on section 8. This same day I found that a very little of section 1 still adhered, and the cotton was little injured. A little was also found on section 2, where the cotton was very little hurt. Section 3 seemed to adhere as well as the preceding, but had scorched the cotton more. Section 4 had scorched the cotton little, but no traces of the poison were left.

September 2, two other sections were poisoned, using one part of flour by weight to two parts or gypsum in place of an equal bulk of flour in Royall's patent.

Date.	Section.	Name of poison.	Substances mixed with—	Weight of poison per barrel, flour.	Length of time before rain.	Effect as an insecticide.	Quantity adhering after rains.
Sept. 2, 1879	9	Paris green	Flour, Gypsum, Dextrine, Rosin	18 pounds*	11 days	Good	....
	10	London purple	Flour, Dextrine, Rosin	9 pounds		do	....

*By a mistake the quantities of rosin, dextrine, and Paris green were intended for twice the bulk of flour and plaster used.

At the time these poisons were applied this cotton was beginning to be honeycombed by the caterpillars; but none large enough to eat through the leaves were to be found on the adjoining sections 5, 6, 7, and 8. Between 8 and 9 a small section was left unpoisoned, and this was defoliated within the next five days, while all of these sections retained their foliage up to the time when I left the field, September 15.

September 4, I noted that the cotton on section 10 was *badly* scorched, though the

worms were killed on it. The poison was as thickly applied on 9 as on 10, yet, despite the double quantity of poison used, it was injured very little. The caterpillars were killed. Very little poison remained on sections 1, 2, and 3, of August 22, yet in a very few places there was enough to kill the worms that were then appearing in large numbers on it. None remained on section 4, the foliage of which was, for the most part, eaten up.

September 7, the poison was found adhering finely to sections 5 and 6, and the cotton was not at all badly scorched. There were very few worms on it. No trace of the poison on section 7 could be found, but there were no worms on it, and it was not materially injured by scorching. Not very much remained on section 8, but there were few caterpillars to be found. The cotton was uninjured. The poison adhered in quantity to 9 and 10, where the worms were all dead. Section 9 was slightly scorched, section 10 badly. The unpoisoned section before mentioned was covered with caterpillars, its foliage being entirely gone.

September 9, about midday, when the sun was shining brightly, I applied poisons to three sections to test the resistance of different substances to the action of the weather. The quantity and quality of the poison being unimportant, I shall give only the proportions of the substances used to dilute it.

Date.	Section.	Weight of flour.	Weight of plaster.	Weight of rosin.	Weight of dextrine.	Length of time before rain.	Quantity adhering after rain.
Sept. 9, 1879	11	4 ounces	24 ounces	1 ounce	1 ounce	4 days	Some.
	12	6 ounces	24 ounces				Do.
	13	2 ounces	24 ounces	1 ounce	1 ounce		Much.

September 14. I noted that my sections up to No. 11 were about as before the rain. Of 11, 12, and 13, all were more or less removed, and strangely enough the last, containing the smallest quantity of flour, had resisted the rain better than either of the others. None of these stood it as well as most of the earlier sections which had already been exposed to numerous rains. Owing to my departure from the field at this time these latter experiments are exceedingly unsatisfactory, and I hesitate to base a very pronounced opinion on them, but think that they go to demonstrate that plaster, unless accompanied by a large quantity of flour, will not do to apply poisons with unless it is absolutely certain that no rain will fall till they shall have time to kill the caterpillars they are intended to destroy.

Arsenic and its compounds.—The only remedies which are now used to any great extent are poisons applied to the plant for the destruction of the larvae, and, almost without exception, these poisons are either arsenic or some compound of that mineral. The compounds of arsenic used to the greatest extent are Paris green, Texas Cotton-Worm Destroyer, and, during the present season, London purple.

Very great difference of opinion exists among planters with regard to the relative value of these substances. This difference of opinion is not only as to their relative efficacy as insecticides, but also as to their effect upon the plants. Thus, although Paris green costs from six to ten times as much as white arsenic, many planters prefer to use the former simply because there is less danger of injuring the cotton plants. With a view to settling these points I planned the experiments conducted by Mr. Trelease, a report of which has just been given, and on going over carefully the testimony of planters which I collected while in the field last year, and the answers of our correspondents, I find that the experience of the majority confirms the results of these experiments in indicating that Paris green is the most desirable insecticide. It seems to act more speedily than the other poisons, and, if used carefully, no appreciable injury will result to the plants; whereas, with arsenic and the other compounds of this mineral with which we experimented, it is difficult to

apply a sufficient quantity to effectually destroy the worms without injuring the plants. We feel sure that the unfavorable results which have followed in some instances from the use of Paris green have arisen from one of the following causes, either an excessive use of the substance or the use of an adulterated article, chiefly the latter. From the trials which we have made, we are inclined to doubt that there is any danger of scorching the cotton if pure Paris green be used in the usual way, whereas we have no doubt that very serious consequences have followed the use of an adulterated article.

We have endeavored to find some simple method by which any planter could test for himself the purity of Paris green. The following, although it does not meet all requirements, will be found useful. Pure Paris green is soluble in ammonia; hence, if you take 100 grains of Paris green and place it in a glass vessel and add one ounce of liquid ammonia (it may require more than one ounce if the ammonia be not strong), and stir it for a minute or two with a glass or wooden rod, the Paris green will completely dissolve, forming a beautiful blue transparent solution. Should there be sediment it will indicate that the Paris green is adulterated, and the amount of sediment will show the amount of adulteration. This test will serve to detect the presence of any of the substances ordinarily used for adulteration of this poison. Sometimes, however, white arsenic is used for this purpose, and as this substance is also soluble in ammonia its presence cannot be detected in this way. By using the above test, however, the planter can be certain that the compound in question will be efficient as an insecticide. There remains only the danger of his cotton being injured by the caustic action of adulterating arsenic. The best plan is to buy the poison directly of the manufacturer. In this case, if care is taken to deal only with reliable firms, little danger need be apprehended.

It is proper to state that although our experiments with the Texas Cotton-Worm Destroyer, as well as those conducted by some of our correspondents in Alabama, failed to produce satisfactory results, many strong recommendations of this remedy have been received from western portions of the cotton belt, especially Texas; and in the circular published by Preston and Robira are recommendations from many prominent planters. An analysis shows that this remedy is an arseniate of sodium, which is almost entirely soluble in water. Of course its value as an insecticide is due to the arsenic which it contains; its only advantage over other compounds of arsenic is its solubility in water, and we are inclined to believe that this advantage is more than counterbalanced by the fact that there is greater danger of injury to the plant from a solution of this kind than by a mere mechanical mixture with water. This point is illustrated by an experiment tried with Fowler's solution.

As to the results of the experiments with London purple, we are disappointed. We had hoped, owing to the cheapness with which it can be furnished, that it would prove a substitute for Paris green, but our experience indicates that it is even less desirable than commercial arsenic. We hesitate, however, to give a decided opinion with only the results of a single season's trial before us, especially as we have favorable reports from Prof. C. C. Bessey, of the Iowa State Agricultural College, who has experimented with it as a remedy for the potato beetle, and from Mr. A. K. Whitney, of Franklin Grove, Ill., who has successfully employed it against the canker-worm on fruit trees, and prefers it to either Paris green or arsenic for that purpose. Still, it should be remembered that the foliage of cotton, being tender, is scorched much

more easily than that of some other plants, and also that a substance may kill certain insects quickly while it acts much more slowly upon others. London purple consists chiefly of arseniate of lime, together with considerable aniline purple, and a little impurity. As it is a waste product in the manufacture of various salts of rose aniline, its composition is not constant. A sample which was analyzed by Dr. Collier shows the following composition:

	Per cent.
Rose aniline	12.46
Arsenic acid	43.65
Lime	21.82
Insoluble residue	14.57
Iron oxide	1.16
Water	2.27
Loss	4.07
	100.00

A compound of arsenious acid and cyanide of potassium has been used to a considerable extent in Texas. It is known as Johnson's Dead Shot. It was patented June 2, 1874. The following extract from the specifications describes the compound:

In order to form my compound I use the following ingredients, and preferably in the following proportions, to wit: Eight ounces of arsenious acid, one ounce of cyanide of potassium, and eight ounces of dextrine, dissolved in forty gallons of water.

Arsenious acid, when applied to the leaves of cotton or other plants in the form of spray, will remain free from evaporation for a sufficient length of time to be eaten by such insects as feed upon cotton or other plants. Cyanide of potassium, when applied in like manner as a component part, might be termed the base of said compound, and serves to hold the arsenious acid in solution before it is conveyed to the plant, and, being among the most deadly of all insect poisons, it not only kills when eaten, but is death to insects the instant it strikes them, and so impregnates the air immediately around the plant upon which it has been deposited that the fly or miller which creates the cotton-worm is instantly killed on coming in contact with, or in the immediate vicinity of, the same; and, being a powerful alkali is easily, absorbed by vegetation, and acts as a tonic or fertilizer, thus entirely neutralizing the evil or damaging effects of the arsenious ingredient upon both land and plant. Dextrine, one of the component parts of my compound, has no poisonous effect, but is simply used to produce a thin mucilage of my other ingredients, sufficient to hold the said compound on the plant to which it may be administered.

No experiments were tried with this compound. We have no doubt, however, that it is effectual as an insecticide; but we would hesitate to recommend the use of a volatile poison so deadly as cyanide of potassium.

Objections to the use of arsenic and its compounds.—Much has been written respecting the dangers attending the use of arsenical poisons as insecticides. We do not here refer to the caustic action of the poison upon the leaves of the plant, but to the injuries which may result to man from the incautious handling of so deadly a poison; to animals by drinking water from vessels in which it has been mixed, and by drinking from streams flowing through cotton fields thus treated, and especially to the danger of the poison accumulating in the soil to such an extent as to exert an injurious influence on the plant. When we consider the immense quantity of this poison which has been used during the last few years, and the low grade of intelligence of the majority of the field-hands who have been required to apply it, especially in the cotton States, it seems as if a great risk of loss of life had been incurred; statistics, however, fail to confirm such conclusions. We occasionally read in the newspapers accounts of serious results following the use of poisons as insecticides, but no well-authenticated case has come to our notice. Although, doubtless, there is danger with the usual care, the

risk is not greater than that of railway or steamship travel or many other practices which are necessary.

These remarks will apply also to the dangers accruing to animals from this use of poison. For, although we are informed that the annual loss by Paris green of cows, sheep, and horses is something considerable, no instance has come under our personal observation.

As to the accumulation of the arsenic in the soil, in sufficient quantity to prove injurious to plants, we cannot do better than to cite the investigations of Dr. William McMurtrie.* These investigations show—

> That, though arsenical compounds exert an injurious influence upon vegetation, yet this is without effect until the quantity present reaches, for Paris green, about 900 pounds per acre; for arsenite of potassa, about 400 pounds per acre.

Thus, if all the arsenic were to remain in the soil no injurious effects need be expected to follow within one hundred years. And when we take into consideration the amount of arsenic which is removed from the soil by drainage, an even greater time may be expected to elapse before that event occurs. And we may reasonably expect that ere that time the science of economic entomology will be so far advanced that a harmless substitute for arsenic will be known if there remains an occasion for its use against this enemy of the cotton plant.

Carbolic acid.—Experiments conducted by Professor Willet and myself last season with carbolic acid gave results similar to those obtained by Mr. Trelease. It was found in each case that where this substance was used in sufficient quantities to destroy the worms it injured the cotton plants greatly.

Kerosene.—Although the different forms of coal-oil have been found to be very valuable in many instances as insecticides, all of our efforts to employ it against the cotton-worm have produced poor results. In every case when a mixture of kerosene and water of sufficient strength to destroy the worms has been applied to cotton, the plants have been injured.

The following experiment, suggested by the use made of kerosene against the Rocky Mountain locust, was tried: A quantity of kerosene was put into a pan; all that would flow was then poured out, leaving only a thin film over the bottom of the pan. A dozen cotton-worms were then put into the pan. At the end of two minutes all were dead. But the danger of injury to the cotton plant, and especially of knocking off the bolls by any machine employed for jarring the worms from the plants into receptacles containing coal-oil, will prevent the use of this substance in this way.

Pyrethrum.—The value as an insecticide of powder made from the dried flower-heads of different species of *Pyrethrum*, and sold under the name of Persian Insect Powder, has long been known, but its expense has prevented its general use except for insects infesting houses and parasites upon domestic animals. For the same reason, we neglected to experiment with it on the cotton-worms, believing that, however efficient it might be, its cost would prevent its use against insects infesting field crops. But there has been introduced into California a Dalmatian species of *Pyrethrum* (*Pyrethrum cinerariæfolium*), from which a powder equally as good as the imported powder is made. And we have recently learned, what is equally important, that this powder can be produced at a price which will admit of its being used on field crops. The Californian powder is known as buhach.

The most important peculiarity of powder made from *Pyrethrum* is that, although deadly to insects, it is harmless to man and domestic

* Annual Report of the Department of Agriculture, 1875, pp. 144-147.

animals. The neglect to experiment with this powder upon the cotton-worms this season is not a serious matter, as it is not yet produced in this country in sufficient quantities to admit of its taking the place of remedies we now have. We understand that arrangements have been made for growing the plants upon a large scale, and before the substance can be put upon the market in large quantities the necessary experiments to determine its efficiency and the best mode of application will have been made.*

Yeast.—In the Canadian Entomologist for June, 1879, Dr. H. Hagen, of Harvard University, published an article on the destruction of obnoxious insects by the use of fungi. The article was based on experiments conducted by Dr. Bail, of Prussia, many years ago. The following extract illustrates the ground taken in the article:

Dr. Bail asserts that he has proved by many skillful experiments that four species of microscopical fungi are merely different developments of the same species. One of them, the fungus of the common house fly, is the vexation of every housekeeper. The dead flies stick in the fall firmly to the windows, or anywhere else, and are covered by a white mold not easy to be removed. The second is the common mold, known to everybody and easily produced on vegetable matter in a damp place. The third is the yeast fungus, a microscopical species, and the basis of the work done by yeast fermentation. The fourth is a small water plant, known only to professional botanists. Dr. Bail contends that the spores of the fungus of the house fly develop in water this last species, out of water in mold, and that the seeds of mold are transformed in the mash tub into yeast fungus.

The experiments made by Dr. Bail cover a period of more than a dozen years, since the numerous results which were made against his results induced him to repeat again and again his experiments in different ways. I am obliged to state that even now prominent botanists do not accept Dr. Bail's views, which he maintains to be true and to be corroborated by new and sure experiments. This question, important as it may be for botanists, is without any influence regarding my proposition, as Dr. Bail has proved that mold sowed on mash produces fermentation and the formation of a yeast fungus which kills insects, as well as the fungus of the house fly. I was present at the lectures of Dr. Bail before the association of naturalists, in 1861, which were illustrated by the exhibition of mold grown on mash, on which the fungus of the house fly had been sown, and by a keg of beer brewed from such mash, and by a cake baked with this yeast. Both productions were declared perfect by all who tasted them—an experiment in which I did not feel obliged myself to join, as both are to be had prepared without the fungus of the house fly.

Although modern mycologists do not believe in the identity of the fungi mentioned, I considered the matter of sufficient importance to be the subject of further investigation. I therefore instructed Mr. Trelease to make the proper experiments to ascertain if yeast torulae sown on insects would give rise to a fungus which would cause their death. The following is the report of these experiments. Care was taken in every instance to see that the yeast was in an active state.

August 1, during a light shower, I applied a gallon of yeast in eight gallons of water to cotton on which there were many half-grown caterpillars, as well as numbers of small ones, using a fountain-pump for distributing the liquid, and being careful to reach all parts of the cotton with it, wetting it, indeed, so thoroughly that the air for some distance was pervaded by a yeasty odor. Before I had finished the shower became heavier, and it rained hard for a considerable part of the night. There was more or less rain nearly every day for the succeeding week. Examination every few days showed that no fungus was attacking the worms.

August 7, I applied several gallons of water in which was yeast in proportions varying from one-half pint to one quart to the gallon of water. This was applied in the morning while the sun was shining brightly, and no rain fell on it until night, though more or less rain fell every day for the next half week. There were worms of all sizes where this was used, but none were attacked by disease.

August 13, more was applied in varying quantities of water, the day being cloudy, but only negative results were obtained.

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*The *Pyrethrum cinerariaefolium* was introduced into California and is raised by Mr. G. N. Milco, of Stockton, Cal.

September 9, after sunset another gallon of yeast in four gallons of water was applied to cotton covered with young larvae and eggs, but with no result, so far as I could see.

It will be seen that the first of these experiments was tried during a rain, which endured for some time, so that the yeast may have been washed from the leaves and from the caterpillars before having an opportunity to act: but if any of it adhered the damp weather following was most favorable to its development into the parasitic form. The second was tried when the sun was shining early in the morning, so that it was exposed to sunlight for the greater part of one day, and could not have been removed by rain till the following night. Like the former, this was subjected to damp weather for a number of days. The third lot was applied in the early part of a cloudy afternoon, and this was subjected to rains the next night and for several days. The fourth lot was applied after sunset, and there was no rain on it for three days. Moreover, these quantities of yeast were so applied as to wet eggs, larvae, and pupae of *Aletia*. Other applications were made on a small scale at different times, but with similar results.

From these experiments it appears that under the most varied circumstances, many of which are very favorable to the growth of fungi, yeast in an active condition failed to produce any fungoid disease on either the eggs, larvae, or pupae of *Aletia*. Furthermore, larvae contained in a tin box were drenched with yeast, being kept thoroughly wet for over twenty-four hours, after which a part of the liquid was drained out, and the box remaining uncleaned, the larvae were kept and fed in it for a week longer, at the end of which time they were still living and apparently suffering from no disease. This leads me to believe that though the *Penicillium* or *Aspergillus* developed from torulae sometimes attack living animal tissues, they cannot be utilized for the destruction of the cotton caterpillar. Yet, considering to what an extent some insects suffer from fungoid diseases, it seems by no means improbable that some practical and economical method of parasiting noxious insects may some day be discovered.

Experiments were also conducted at the department upon insects in my breeding-cages, but I was unable to see that any results were produced by the yeast.

MODES OF APPLYING POISONS.—Second in importance only to the choosing of the most effectual poison is the adoption of the best mode of applying the remedy. Although many methods have been adopted, they may be classified under two general heads: First, use of poisons diluted with water; second, use of poisons diluted with some dry substance.

Before entering upon the discussion of these methods, I wish to urge the importance of making early preparations for poisoning. As yet most planters do not seem to realize that fighting the worms is a part of the necessary labor for raising a crop of cotton. As a rule no provision is made for this work in the way of purchase of poison or implements for its distribution, or conveniences for getting water, until the worms are injuring the crop so badly that it is evident that something must be done at once to save it. The result is that while the planter is engaged in the preliminary work which should have been done months before, the crop is destroyed.

The following remark was made to me in almost the same words by the majority of the planters with whom I talked upon the subject: "The trouble about poisoning is, a man may have a large field, the worms appear in it, and in three or four days the crop is destroyed before the poison can be applied." Another expression which I often heard, and which is equally suggestive of a lack of appreciation of the proper way in which to contend against this insect, is the following: "The first and second crops of worms do no harm; it is not worth while to poison them; it is the third crop that does the injury."

The cotton-worm will continue to be a scourge until all who raise cotton, except perhaps those in the northern portions of the cotton belt, incorporate in their estimate of the cost of producing a crop the expense of poisoning the worms. The fact that in almost every section there are seasons during which the worms injure the cotton but little can almost

be considered a misfortune; for it is doubtless largely owing to this that proper preparations are not made. Influenced greatly by their hopes, the planters believe each spring that it is not going to be a "worm year." The result is that already described. It would be better to make unnecessary preparations than to suffer for want of proper precaution; especially as, if there is no occasion to use the materials the season they are purchased, they can be kept without loss or damage until there is occasion to use them.

Doubtless in many cases one reason why the preliminary arrangements are not made at the proper time is the financial depression which has been so general throughout the South. Many planters find it necessary to borrow the money which is used in the cultivation of the crop, and under such circumstances do not feel willing to go to the expense of buying poison and machines for distributing it when there is a chance that they will not be needed, and in any case the interest on the investment is to be met. Still we believe that under these circumstances the loss incurred by the lying idle of capital invested in this way ought to be regarded in the light of insurance.

If the poison to be used be purchased during the winter there will be time to procure it directly from the manufacturers, thus saving considerable in cost, and, what is of much more importance, an unadulterated article can be obtained. Frequently those who wait until they need poison before buying it, and are thus forced to purchase of local dealers, pay from 20 to 75 per cent. more for an inferior article than an unadulterated poison would have cost if bought directly of the manufacturer at a season when there is no great immediate demand for it. In a similar way, in case dry poisons are to be used, doubtless many opportunities would occur for procuring flour at a less cost than it would be necessary to pay at the time it is to be used.

A very great saving of time may be accomplished by those who apply poisons with water by improving the facilities for getting it. The details of this will vary with local conditions. We are led to speak of it from our observation in the canebrake region of Alabama. Although this section is one of those which has suffered most from the cotton-worm, and at the same time one which is admirably adapted for providing supplies of water, little has been done in this direction. A large part of this region is supplied with artesian wells which bring the water several feet above the surface. Doubtless it would pay, in many cases, to sink wells in those parts of the plantation where water is most likely to be needed for poisoning; at least tanks should be arranged at the existing wells so that barrels could be rapidly filled in time of need. This, however, is seldom done. In those sections in which cisterns are used instead of wells, it would pay to make one or more cisterns in each of the larger cotton-fields, and to see that they were properly filled during the rainy season.

We wish also to urge prompt action in the use of poisons. We are convinced that it does not pay to wait for the third crop of worms before poisoning the cotton. The earliest brood in the spring should be destroyed. At this season it probably would be necessary to poison only the cotton growing on low land. Let those places in which the worms are known by tradition to appear first each season be early and thoroughly poisoned. The expense of this poisoning need not be great, for not only are such areas of limited extent, but, as the plants are small, little poison will be required. It will probably pay best to use dry poisons early in the season, as but little flour will be needed on each

plantation, thus doing away with one of the greatest objections to dry poisons.

The poison should be first applied at a date not later than twenty days subsequent to that when the cotton first appears above ground. It will probably be found necessary, as the successive broods of worms appear, to poison larger and larger areas, until, with the third crop, all the cotton growing should be poisoned; doubtless, however, it would frequently occur that only the rank-growing cotton would need to be poisoned even then. If concerted action were taken throughout any extended region in poisoning early in the season, we do not believe that the worms would be able to develop in sufficient numbers to do any serious injury; at least, their progress might thus be retarded, so that the cotton would not be stripped until too late in the fall to do damage.

Wet poisons.—The least expensive mode of applying poisons, and the one most generally adopted, is with water. When Paris green, arsenic, or London purple is used, it is necessary to stir frequently the water into which the poison is put, as none of these substances are soluble in water. In applying the mixture every leaf should be thoroughly wet, and the proportions used should be such as to distribute from twelve ounces to one pound of Paris green over an acre; with the other poisons a smaller amount must be used, on account of the danger of scorching the cotton.

When Paris green was first applied with water common watering-pots were used. A man mounted upon a mule carried the pot and sprinkled the plants as he rode along the rows. Other hands kept this one supplied with the mixture. This was found to be a very imperfect method, requiring, as it does, a great amount of water, which is a serious objection when the water has to be drawn a considerable distance, as is usually the case. Moreover, by this method the poison is not evenly distributed; the hand (almost invariably an ignorant and careless negro. and, perhaps, half asleep) rides along and deluges some plants, while others are not wet at all.

The most practical way of applying wet poisons that has come under our observation is by means of a machine known as the fountain-pump. This is a simple instrument, the form of which is shown at Plate XIV, fig. 4.

It consists of two brass tubes, one working telescopically within the other; a hose is fastened to one end and a nose can be attached to the other; this nose is represented in the lower part of the figure; an arrangement of valves allows water to pass into the pump through the hose, but will not allow it to return. Thus, when the smaller tube is pulled out, the pump is filled to its greatest capacity: by pushing this tube back, the water can be ejected with considerable force through the nose in a fine spray. In this way, with a single pump, a man can throw the poison over five rows of cotton at once, walking rapidly along the rows. Thus five rows can be poisoned in about the same time that is required to poison one row with a watering-pot. In addition to the saving of time, much less water is used with the fountain-pump than is required with watering pots; and as the pumps throw a very fine spray, the poison can be more evenly distributed in this way.

In using the fountain-pump, one man works the pump, another hand (often a woman) accompanies him and carries the bucket containing the mixture. Other hands keep these supplied with the poison. As some parts of the work are more tiresome than others, the hands are transferred from one part to another at intervals. The water is conveyed to and about the fields as far as possible in wagons.

It is estimated by those who have had much experience in applying

poisons in this way, that where water is easily obtained, with one fountain-pump and eight hands (three of whom may be women) 25 acres of cotton may be poisoned in one day. The eight hands are distributed as follows: One works the pump; one carries the bucket from which the poison is pumped; three supply this one with the mixture; three are with the wagon getting water and mixing the poison.

Although the plan just described is the one most generally used, we think that adopted by Mr. Trelease during the present season is preferable, requiring as it does fewer hands. This method is illustrated in Plate XV.

A 40-gallon barrel containing the mixture is placed on an ordinary four-wheeled wagon, the wheels being 5 feet apart, and the lowest axle 23 inches from the ground. The wagon is drawn by two mules, these walking in the furrows on either side of the row of cotton over which the wagon passes. One hand drives the team and two others provided with fountain-pumps distribute the poison from the barrel. In this way nine rows of cotton are poisoned each trip across the field. In ordinary cases one or two other hands with a team can keep these supplied with water. By this method poison can be applied very rapidly and with a minimum number of hands. The experiments show that the cotton was not seriously injured by the team or wagon, although much of it was as high as the top of the wagon-box, and there was none that was not bent as the axle passed over it. Certainly the time and labor saved will, except in cases where the cotton is very high and closely interlocked between the rows, more than pay for the injury done to the cotton. I suggest the following improvement to the apparatus used this season: Have a cover fitted to the barrel to prevent the spilling of the poison. This cover should have three holes; one for a dasher (similar to that used in churns) for agitating the mixture; the two other holes to admit the hose of the pumps. The dasher may be worked by a boy or the men with the pumps.

Although the method above described is the most practicable yet devised, we feel that it can be improved upon. Our observations convince us that the thing most needed is a machine which can be drawn by one or two horses and which will throw a spray of water on the under side of the leaves.

The present modes of poisoning are defective in that they require a large force of hands, often when there is much other work to be done; and what is a much more serious matter, as the poison is applied to the upper side of the leaves of the plant, the young larvæ are not killed until they are large enough to eat through the leaves. This would be of less importance could the poison be made to adhere to the leaves; but it often happens that the mixtures are washed off the plants by rains soon after being applied, while if they were applied to the lower surface of the leaves all larvæ feeding at this time would be poisoned, besides there being less liability of the poison being washed from the plants.

A machine intended to meet these requirements has been invented by Mr. W. T. Daughtry, of Selma, Ala. This consists of a large cylindrical reservoir mounted upon wheels and provided with an agitator for keeping the compounds well mixed. Force-pumps, which are worked by gearing attached to the hub of one wheel, force air into the reservoir; the pressure obtained in this way forces streams of fluid through the distributing pipes; each pipe extends nearly to the ground and is bent upward at the end, which is furnished with a peculiar nozzle; in this way a fine spray can be thrown upon the lower surface of the

leaves. The machine is made to pass over two rows of cotton, and the distributing pipes are so arranged that four rows can be poisoned at a time. Owing to its great weight, the machine in its present form is impracticable, but the idea which it embodies is a good one. Mr. Daughtry's machine was patented February 19, 1878, No. 200576. It is figured in the special report, p. 232.

Mr. John A. Wolfram, of Meyersville, Tex., has also invented a machine which throws a fine spray upon the lower surface of the leaves. An application for a patent of this machine is now before the Patent Office.

Mr. John W. Johnson, of Columbus, Tex., has patented a machine for distributing liquid poisons upon cotton plants. This machine has been used to a considerable extent in Texas; it is represented in Plate XVI, Figs. 2 and 3.

The following description will explain its workings:

This invention relates to certain improvements on that for which I filed an application for letters patent on the 22d day of September, 1873; and the invention consists in a tank provided with a double-acting force-pump, communicating with a pipe and branches similar to those described in my application aforesaid, the pump being connected by a pitman with one of the wheels upon which the tank is supported, whereby the pump is operated automatically as the apparatus is drawn along, the wheels upon which the apparatus is supported being much smaller in diameter than ordinary cart or wagon wheels, and attached to the tank by means of vertical bars, whereby the apparatus is enabled to pass over the rows of cotton plants without injuring them, while at the same time the dimensions of the wheels are such as to give the required number of strokes to the pump-lever necessary to the producing of a constant and full volume of spray from the pipes.

In the accompanying drawing A represents the tank containing the liquid compound described in my application aforesaid. Instead of placing it upon an ordinary cart or wagon and working the pump by hand, I attach the tank to a platform or cart-bed, B, provided with two wheels, C. These wheels are much smaller than ordinary cart-wheels, being about twenty or twenty-four inches in diameter, in order to give the required number of revolutions necessary to the successful operation of the pump. In order to place the cart-bed at such an elevation as to enable it to pass over the rows of cotton plants without injuring them, I attach to each side the upper end of a bar, the lower end of which is bent outward and formed into a spindle or axle for the wheel. These bars are of such length that when the wheels are in place the height of the cart-bed from the ground is equal to that of a vehicle provided with wheels from five to six feet in diameter. The wheels C may be of cast-iron, and the bars D may be of wood or iron, as may be preferred. One of the wheels C has a crank-pin, *c*, formed on or attached to it at a suitable distance from the center, and to this crank-pin is attached the lower end of a pitman, E, the upper end of which is attached to the pump-lever G. By this arrangement the pump is operated automatically as the apparatus is drawn over the field, thus dispensing with the labor of one man for operating the pump. The pipe and branches are arranged and connected with the pump in a similar manner to that shown in my application aforesaid, the supply-pipe H being provided with a stop-valve, I, to regulate the flow of the liquid. The branch-pipes K are made of cast metal, instead of sheet-metal, as shown in my application aforesaid, and instead of corrugating the metal as therein shown, I form the grooves *l* on the inner surface, either during the process of casting or by planing or cutting them out afterward, as may be preferred. The branch pipes thus formed are cheaper and more durable than those formed of corrugated sheet-metal.

Dry poisons.—The dilution of poisons with powdered substances instead of water has been adopted to a considerable extent, and in some respects is far superior to the latter. The greatest obstacles that planters have had to encounter in the destruction of cotton-worms is the removal of the poison from the plants by rain. It frequently occurs that before a planter has completed poisoning a field a sudden rain undoes the work just performed. This obstacle is especially serious, as the rainy seasons are notably those in which the worms most rapidly multiply. In fact, many planters have been discouraged and abandoned the use of poisons on this account. This difficulty is, to a great extent, obviated by the use of flour as a diluting substance. The flour combining with dew or

rain forms a paste which glues the poison to the leaves. This fact has been so well established that it is unnecessary to enlarge upon it. A single instance may be cited as an example: During the present season, on Capt. George O. Baker's plantation at Selma, Ala., the mixture known as Royall's patent withstood five days of continual rain.

Our experiments show that poison mixed with flour alone adheres nearly as well as the above-named mixture, resin and dextrine seeming to have but little action. It was also found that flour can be diluted to a certain extent by gypsum or land plaster. But poison mixed with plaster alone adhered but little better than when applied with water.

Another advantage gained by the use of dry poisons is that there is less danger of injuring the cotton than when water is used.

The great objection to this method of poisoning is its cost, the price of the flour adding materially to the expense; and, also, no way has yet been devised and brought into general use of applying dry mixtures as rapidly and easily as liquid poisons may be applied. We believe, however, that unless some method is devised for throwing a spray of liquid poison upon the lower surface of the leaves, where it will be less liable to be washed off by rain, dry poisons will be found most practicable; and we feel sure that the objections of the expense can, to a great extent, be removed. Further experiments are necessary to devise a cheaper method of distributing powdered substances over plants, and to determine to what extent the flour may be profitably replaced by plaster or some other cheap material. The cost of the flour can doubtless be lessened by using a poorer quality, which might be manufactured for the purpose from inferior or injured wheat. If a machine could be invented by which a mixture of one pound of Paris green and two pounds of flour could be quickly and evenly distributed over an acre of plants, the same end would be gained.

The simplest method of applying dry poisons, and the one most generally used, is by means of a tin vessel holding about a gallon, provided with a handle and having a bottom made of perforated tin. By means of this the poison can be sifted over the plants. This, however, is a slow process, as only one row at a time is poisoned.

Some planters practice sowing the mixture when there is a light wind, being in this way enabled to poison several rows at once. Aside from the fact that the conditions favorable for this method cannot be relied upon, the poison cannot be as thoroughly distributed as is desirable.

A device has been invented by Mr. J. W. Young, of Southfield, Mich., for dusting Paris green upon potato-vines; by means of this, two rows can be poisoned at once. The form is shown in Plate XVI, fig. 1.

The weight of the apparatus is balanced upon the shoulders by means of a neck-yoke, thus leaving the hands and arms free to move the handles. Each handle is attached to a brush that works horizontally across holes in the bottom of the can. The cans are adjustable to the width of the rows or height of crop. Doubtless this machine would be found much better than the hand-dusters, especially when poisoning small cotton.

Plate XVI, fig. 4, represents a machine patented by Mr. Nicholas A. Davis, of Rusk, Tex.

No. 1 represents the invention attached to a cart; No. 2 is a cross-section through the line *y y*.

In the drawings, A represents an ordinary farm-cart, across the rear end of which is secured the horizontal shaft B, having its bearings in the arms *c c*, projecting behind the cart. On the shaft B, I place two or more loosely-revolving perforated cylinders, E, being revolved upon the shaft, which carries a pulley, *a*, over which a band or cord

works, passing to the hub of the cart-wheel, from which it receives motion, and thus causes the shaft B to revolve when the cart is in motion, and the shaft, carrying the perforated cylinders, previously filled with the powdered poison, causes the poison to be sifted out and distributed over the cotton plants. Attached to the inner end of each of the outside cylinders is a spiral spring, *b*, coiled around the shaft A, and so arranged as to secure an easy, gentle, lateral motion to the cylinders in case of a sudden jar given to the machine, and thus prevent too great a discharge of the poison at any one point.

It is evident that a similar spring may be used at the opposite end of the cylinders, so as to check the jar in both directions.

From the above description of the invention, it is evident that it could be affixed to any kind of frame moving on wheels, and by a hand-crank and ordinary cog-gearing be successfully worked.—[Patent No. 154651, dated September 7, 1874.]

Many other machines have been invented for the distribution of poisons, both wet and dry. We figured and described several of them in our special report. But as they have not to our knowledge been thoroughly tested as yet, we cannot in our limited space reproduce the figures and descriptions here.

DESTRUCTION OF LARVAE BY MACHINERY.—Two machines have been invented and patented for the purpose of brushing the worms from the cotton plant and destroying them. Both of these machines are figured in the special report (pp. 253–255); neither, so far as I have been able to ascertain, have come into general use. It is doubtful if a practical machine of this kind can be constructed, owing to the danger of knocking off the bolls of cotton when in operation.

DESTRUCTION OF PUPAE.—Although the collection and destruction of the pupae of *Aletia* at the season during which the greatest damage is done would be impracticable, much good could be accomplished in this way if attempted at the proper time. Early in the season, while the cotton plants are small, it is an easy matter to detect the presence of pupae by searching for the folded leaves containing them. As already suggested, when treating of the collection of larvae by hand, it doubtless would be profitable to offer the negroes a prize for each pupa obtained at this time. The folded leaves are so easily observed that with little care nearly every pupa in a field could be collected while chopping out the cotton in the spring. In the autumn many pupae could be destroyed by collecting together and burning the weeds in the leaves of which the larvae have webbed up. This should be done as soon as possible after the last brood webs up, and before the moths emerge from the pupae state.

DESTRUCTION OF MOTHS.—The two most successful methods of destroying the moths that have been used are the placing of sweetened poisoned solutions about the cotton fields and the use of fires or lanterns so arranged that the moths can fly into the blaze, or so that they can be destroyed in some other way.

(*a*.) POISONED SWEETS.

We have already shown how the moth of the cotton-worm is attracted to sweets, as the nectar of various plants, ripe and decaying fruits, and this proclivity very naturally suggests the use of poisoned baits. Years ago this was practiced very much more extensively than at the present day. Mr. Glover long recommended this remedy in the Department of Agriculture Reports, his first mention of it being a detailed account of the phenomenal success of Col. B. A. Sorsby, in the report for 1855. The old files of the Southern agricultural papers contain frequent mention of the use of the method. One of the most remarkable statements was contained in the Southern Cultivator (Vol. VIII, p. 132) to the effect

that the writer had, with 80 plates of poisoned molasses and vinegar, averaged 1,000 moths a night throughout the season.

The answers of correspondents to question *7a* of the 1878 circular show that this remedy has almost entirely fallen into disuse. Some planters, however, still believe in its efficacy. We may quote the following:

But few efforts have been made to destroy the moths, farmers of late years chiefly relying on poisoning the worms; however, the idea is gaining foothold that it is better to try and destroy the moth and thereby prevent the appearance of the worm in destructive numbers. The best mode seems to be to set up lights in the field above or in front of some sweet adhesive substance. Moths appear to be attracted by all sweet substances. I have seen them attracted by thousands, after the first brood had webbed up, to dried peaches that were dried on boards in the sun, and had been covered up at night with boards, the moths collecting by thousands under the covering of the dried peaches, hundreds being killed by a lamp in a short time. A mouse made a nest with the dead moths the same night.—[J. H. Krancher.

Watermelons cut open and spread around with arsenic sprinkled on will kill the moth.

I used, with full effect, the arsenite of soda combined with a little vinegar and molasses. I did not use any intoxicating liquids, as I was fully satisfied that every moth imbibing the poisoned sweet was instantly killed; none of the dead appearing at any appreciable distance from the pans.—[W. J. Jones.

Little or no effort has been made. My opinion is that something should be done with poisoned molasses and fires or lamps. A few nights ago I placed a cup three inches in diameter, with a little molasses in it, a distance from lights and cotton plants, and found six moths in it next morning, all of them cotton-caterpillar moths. A year or two ago I divided an overripe watermelon and placed it in a similar position, and by eight o'clock at night there were 50 or 75 moths feeding on it.—[Jno. Bradford, Leon County, Florida.

The following testimony is from Dr. Anderson:

As an instance of the effect of light and its fondness for sweets, I will mention what a neighbor told me, and for which, to a great extent, I had ocular demonstration. He was engaged in boiling sirup from the first of September to the last of October. His yard, where the evaporating pan was, opened upon a field of 60 or 80 acres of cotton. He each morning found his pan covered with moths, and from first to last thought he had emptied out one bushel of moths. Another case showing strikingly the effect of lights and sweets was told me by a highly valued Texas correspondent. A neighbor of his, by the use of lights and poisoned sweets, had made 1,000 bales of cotton on 1,000 acres, while his neighbors who had not used them had been badly damaged.

During the season of 1878 experiments were made by Professor Smith, at Tuscaloosa, Ala., in the latter part of the season, and by Professor Willet and myself earlier. Concerning Professor Smith's results, we quote from his letters:

October 10, 1878.—Since writing to you last I have done all I could towards observing the habits of the moths, experimenting with poisoned sweets, &c. As yet I have not been fortunate in getting a solution by which the moths are readily killed. I have tried corrosive sublimate and arsenious acid, and with them molasses and water in various proportions. The solutions I have smeared upon pine trees standing in the field, upon little shelves set up at places in the field, and upon a dish placed upon a stump. To one pine tree in particular the moths seemed to be attracted most strongly. The shelves attracted very few comparatively. I am still engaged in these trials with shallow dishes with perforated shelves, according to your suggestion, and I shall let you know if I find out anything.

October 16.—Since writing you last I have continued my experiments with various poisoned sweets; but, I am sorry to say, with but very poor success so far as killing the moth is concerned. I have used for poisons arsenious acid, corrosive sublimate, strychnia, and potassium cyanidi; these I have mixed in varying proportions with rum and sweetened water. The bait appears to be attractive enough and I see the moths partaking of it, and yet no dead moths are visible next morning. The proportion of rum which I have mixed with these poisons has been sometimes one-half, and from that down. Of the poisons named above, the potassium cyanidi is perhaps most easily soluble in the liquids used. Smearing the sweetened liquids upon the trunks of trees is, according to my experience, the best way of exposing them; I have not seen many moths around the dishes set up on shelves and on stumps. I constructed a

shelf against a pine tree and upon that placed a dish with the sweets, and provided with a floating perforated platform. The tree was at the same time smeared with the liquid, and upon visiting the place after dark I noticed a number of moths on the tree, on the smeared shelf, and on the dish with the platform, those on the dish being much less numerous. * * * About the time that the worms were moving off and webbing up, very few moths visited the sweets at night for several nights, but last night and the night before that they were more abundant. Perhaps the cool weather was the cause of their being absent for several nights, since they have come in numbers again after the warmer nights have set in.

November 4, 1878.—I send by to-day's mail a few specimens of the moths attracted by my baits. No. 1 is, I presume, *Aletia* (*Aletia argillacea*); No. 2 is *Agrotis ypsilon*, always present in cold as well as warm weather, and No. 3 (*Leucania unipuncta*) also; No. 4 (*Amphigyra*, sp.) resembles 3 and may be same species; No. 5 (*Orthosia ferruginoides*) I see occasionally on warm evenings; No. 6 (*Chrysis*, sp.) I found to-day. I should be very glad to get the names of the specimens as they are numbered. I inclose a few of the chrysalides of the last brood of worms.

The evening of October 26 was warm (65° at 7 p. m.), and more than 50 *cotton-moths were counted at my baited tree.* It rained before morning and then cleared off cold, so that on the 27th and 28th no moths were seen. On the 29th it was warm and cloudy and rained slightly, and I counted 7 or 8 *Aletia* moths. On the 30th, 31st, 1st, and 2d cold and frosty nights; no moths seen.

Professor Smith continued his sugaring all through the winter, capturing many other moths, but no *Aletia* later than December 1.

The observations of Professor Willet and myself were reported by Professor Willet as follows:

Peaches.—Professor Comstock learned in Alabama that the *Aletia* moths had greatly injured the August crop of peaches. On the night of September 10 Professor Comstock placed two peaches—clear-stoned and quite ripe—one on each side of two stumps on whose sides molasses had been smeared, and visited them at 9 p. m. We (Professor Comstock and myself, Professor R. having left for Washington) found 20 *Aletia* moths on one peach and 15 on the other, notwithstanding the molasses. At 7 o'clock next morning nearly as many moths were at the peaches, though the sun was an hour high. One peach had a hole one-thirty-second inch in diameter, and the peach had been eaten out underneath the skin to a depth of one-fourth inch and a diameter of 1 inch. The other peach had 5 holes, not so large, and probably 50 excoriations one-fourth inch in diameter. They clustered most about the stem end, where they could thrust in their bills without effort.

September 12.—The halves of the same peach, opened, were placed out last night, and 10 *Aletia* and 1 other moth were found at them this morning.

Some *dried peaches* (with skins on) having been soaked in water, were placed out at same time, but no moths were found at them. After returning here, two hard peaches were put in a jar where some moths had hatched from chrysalides; the moths were almost famished and immediately clustered over the peaches, but failed to make any impression on them.

POISONING THE MOTHS.

1. *Molasses.*—Mixed Fowler's solution of arsenic with common molasses, 1 tablespoonful to 1½ pints, and placed some in tin pan, with floating perforated cover of tin, as suggested by Professor Riley. After about two hours we found 2 *Aletia* and 2 other moths sipping; next morning probably a dozen of *Aletia* and other moths were found drowned in the molasses, having insinuated down by the sides of the cover; none dead on the ground.

Mixed some of same poisoned molasses with sirups of strawberry, orange, and pineapple, and with rum, vinegar, and lager beer, and smeared on trees and stumps in the cotton field and adjoining forest. At 9 p. m. found 1 *Aletia* and 2 other moths at the vinegar and 2 *Aletia* at the beer; at 7 next morning found only one feeble *Aletia* at the beer. The poison did not seem to be strong enough.

2. *Peaches.*—September 12, we put out in the cotton field, in large paper boxes—

a. Peaches (halves) thickly sprinkled with white arsenic.
b. Peaches (halves) drenched with Fowler's solution.
c. Dried peaches (soaked) covered with white arsenic.
d. Dried peaches (soaked) with Fowler's solution.

Visited boxes next morning with the following result:

a. Five dead *Aletia*, 2 disabled *Aletia*.
b. Two dead *Aletia*, 1 dying *Aletia*.
c. Two *Aletia* in box not dead.
d. No moths of any kind.

As peaches seemed so attractive, we desired to have tested the poisons further with peach preserves and canned peaches, but a northeast gale prevailed until the last day of our stay, and the moths had then almost entirely disappeared.

My own opinion is that peaches, in some form, will be the best vehicle for poison for the moths.

A letter from Judge Bailey, of Marion, Ala., contains the following, bearing upon this point:

One farmer informed me that the moths utterly destroyed a large fig crop in less than a week. Another informed me that all his best apples were punctured and sucked into a sort of honey-comb work by the cotton-miller. A physician in the northwest part of the country assured me that the army-worm sucked his grapes dry in three nights. I know the moths are strongly attracted by cider pomace from the cider-mill. They feed upon ripe persimmons with great avidity. I observed them around a tree of this kind on my lot as late as the 21st of November last. While they were feeding on the fruit of this tree I made some efforts to poison them, but with poor success. I tried several poisons handed me by an apothecary; only one had any effect. It was cobalt, finely powdered, and mixed with the fruit mashed with a small quantity of honey. The flies sought the bait in great numbers, but, like bees, they sucked their fill and left; only nine were found dead around the saucer containing the poison.

With respect to observations the present year, the following from Mr. Trelease's report will give the results at which he arrived:

Since the perfect form, or moth, of *Aletia* is known to feed upon sugared substances and fruits, and since it is known to be attracted by light, to a certain extent, it has been thought possible to destroy the moth by allowing it to feed on poisoned sweets, or by employing this food or lights to attract it into traps of various sorts.

As will be seen by referring to my report on the food of these moths, they are attracted in large numbers by ripe apples, peaches, and grapes, beside one or two other less common fruits; but I signally failed to attract them in numbers to my mixtures of molasses or sugar and various substances. Though no experiments on a large scale were conducted, I feel confident that poisoned dishes of ripened and slightly fermenting fruits which have been bruised may be advantageously employed for the destruction of these moths, by placing them about the cotton fields when the moths are flying. I would recommend that this be tried, especially on warm days in winter, when the moths are allured from their hibernacula, in the early spring, and in the fall, after the brood which destroys the cotton has emerged as moths.

From all observations it seems probable that a preparation of over-ripe fruit—peaches, melons, mashed apples, or persimmons—will be superior to any other sweet mixture for the purpose of attracting the moths, although, as shown by Professor Smith, one-half each of rum and molasses and water, when smeared upon the trunks of trees, has proved attractive.

Actual results with poisons have proved rather unsuccessful, but this may be owing to the fact that the moths fly away to die. As regards the best poison, Judge Jones seems to have had excellent success with arsenite of soda, while Judge Bailey considers the so-called "cobalt"* the best thing that he tried. It is called "blue-stone" or "fly-stone," and is customarily used in fly poisons.

And now, as regards the advisability of an extensive use of poisoned sweets, it is a question for every planter to decide for himself from the evidence laid down.

There can be no doubt but that it would be an excellent plan to try it in those regions where hibernation is suspected on the spots where the worms first appear. The sweets should be put out in these places in early spring and also in late fall. The importance of the latter is evinced from the fact of Professor Smith's success in October. There can certainly be no doubt but that every moth killed saves the planter from a great many worms, but the hibernating moths are, of course, of im-

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* The ordinary cobalt of druggists is nothing more or less than impure metallic arsenic, costing from 6 to 15 cents per pound. Called cobalt on account of former laws against the selling of arsenic in England.

mensely greater importance than those of any of the succeeding broods. Concerning the later broods, the cost of poisoning must be set against the numbers of moths killed, and each planter must decide for himself whether it will pay him to continue.

FIRES, TRAP-LANTERNS, ETC.

For many years the practice of building large fires at different points through the cotton fields for the purpose of attracting the moths into the flame was prevalent. The use of such fires was, however, discouraged by a class of planters, whose opinions were thus expressed by a writer in De Bow's Review:

I have tried this remedy, and have remained in my cotton field after dark to watch the effects of the fire on these flies. I did not see as many destroyed as I expected when I took into consideration the quantity I knew to be in the field. The most of those I saw approaching the fire seemed to be repelled or diverged off on nearing it, or they would rebound high above it and escape destruction. On seeing this I came to the conclusion that the heat of the large fires extended too far around, and that they felt it, and turned off before being near enough to be destroyed.

As a result of this belief and of the evident fact that, unless generally practiced, a fire upon one plantation would serve only to attract moths from neighboring plantations, concentrating them upon one crop, the custom has fallen into disuse.

The first of these objections cannot be urged, however, against the use of trap-lanterns. As a good instance of the success of these last, we quote the following from the monthly reports of this department for 1867:

Parish of Jefferson, Louisiana.—Allow me to call your attention to the destruction of the cotton crop by the worms, which appear to increase yearly. In 1864 I planted about 100 acres in cotton. In July the worms made their appearance. Having no experience in raising this crop, I searched in the agricultural reports for information. Mr. Glover recommended the burning of trap-lanterns, and I made three of them with a coal-oil lamp and tin basin, with soapsuds underneath, and burned them every night. The first night I caught about 75 millers and innumerable other insects. The number increased to 350 millers, and then gradually diminished to none. For three weeks after the crops of my neighbors were destroyed; I found only a few of my plants attacked; about the last week of the three I caught no millers, but all at once the catch was 75; next night 150, then 300, and even up to 500. The worm, however, gradually made its appearance more and more, until, in the middle of August, my cotton was stripped of every leaf and bloom. The worm then turned into pupa. In ten days after this the miller again appeared. Meanwhile the cotton had sprouted again and was in full bloom, when the third brood made its appearance in immense numbers. In three days every leaf and young boll was eaten, and the worm was eating the bark of the plant and the glazed protection of the nearly matured bolls. The heavy rains of September soaked into the bolls and rotted them. I made only 3 bales of cotton. In July the prospect was good for at least 75 bales.

My opinion is that if every planter would commence burning a lantern in each five acres, from the latter part of June to the middle of September, for a few years in succession, both the boll-worm and the cotton-worm would be destroyed. The boll-worm destroys about one-half the crop with us. This year none of my neighbors raise cotton. I have planted about five acres, and shall burn one lamp, and inform the department of the result. Cost of lantern and basin about $1.50, and the oil will not cost over $1, so that if the increase is only 10 pounds to the acre it will more than pay the expense. The first night I used the lantern on a barrel, but the insects were alive in the morning, and it was considerable trouble to kill them. Afterwards I used the soapsuds, as it killed all the insects at once.

The following extract from a letter of Mr. E. A. Schwarz possesses interest in this connection:

Col. C. Lewis, of Hearne, Tex., after experimenting for a long time with more or less complicated contrivances to attract by light, and at the same time to kill the cotton-moth, concluded finally that the following simple apparatus is the most effective and cheapest. As now in use, this apparatus consists of three pieces: 1st, a shallow

tin pan (16 by 10 inches); 2d, a common kerosene-lamp, with a half-inch wick, and large enough to burn the whole night; 3d, a common lantern, open below, which is put over the lamp to protect it from wind and rain. The lamp is put in the middle of the pan and prevented from sliding by three pieces of tin fastened on the bottom of the pan. This apparatus is put on top of a post, about 6 feet high, in the field. Before dark the lamps are made ready, the pans about half filled with water, and about one tablespoonful of kerosene is put on the water.

To put this kerosene on the water is the most important part, and the colonel experimented with all sorts of chemicals—alcohol, camphor, iodine, &c.—without finding anything which would kill the moths, which, attracted by the light of the lamp, fly against the lantern and fall finally into the water. Kerosene alone proved most effective in killing these moths. The lamps are left burning in dark nights the whole night over, but are, of course, of but little use at full moon. In the morning the pans are emptied and the lamps extinguished. Colonel Lewis believes that one lamp for each 5 acres is sufficient. One man can attend to 500 acres. The cost of a lamp (which is manufactured by H. K. Davis & Co., Hearne, Tex.) is 50 cents, but will last, of course, for many years. The cost of burning one lamp and labor amounts to 35 cents per month. Colonel Lewis put his lamps out last year the 20th or 25th of June, and had them in use about six weeks, with interruptions caused by clear moonlight nights. Almost all the large farmers used these lanterns last year, and it is estimated that in the bottom-lands near Hearne more than 1,000 lanterns were out in 1878, which is the first year in which this method of killing the millers has been tried on a large scale, and it is not possible to say anything that is definite regarding its value. There has been last year no poisoning of the worms carried on whatever in this section, notwithstanding the crop was a fair one—about one bale per acre.

Myriads of the cotton-moths have been killed, of course, by this method, and it appears certain that it proved most effectual against the ravage of the boll-worm, which in 1877 did more harm here than *Aletia* (the cotton crop in 1877 was here a perfect failure, owing to the combined ravages of *Aletia* and *Heliothis*), and which was killed in great numbers by this method. Before the introduction of the method just described, the large planters in the bottom-lands tried to poison the worms, but with little success.

The method described above to destroy the cotton-moth is, in my opinion, superior to all similar methods and to all applications of poisons; but the lanterns ought to be lighted up at the beginning of May, if not earlier, and not toward the end of June.

The following extract from Mr. Trelease's report give the results of his observations upon this point:

From what has been said in the earlier agricultural reports, and from the testimony of planters as to the attraction of light for these moths, I had supposed that the easiest and most scientific method of destroying *Aletia* was to employ fires into which they should be attracted, or lights in combination with some form of trap, either with or without the added attraction of food; these to be used whenever the moths were flying, and their use enforced, if necessary, by legislation. Considering, for the above reasons, that the fondness of these moths for light was proved, I made no efforts to obtain personal demonstration of the fact; and it was only on learning how many species of moths and even of other insects may pass for *Aletia* with the ordinary observer, and on seeing from my notes how little attention was paid to the light of my lantern, that I began to doubt the efficacy of this remedy; but this, unfortunately, was after I had left the field. As it is, I can only say that the number attracted to lights, as compared with the entire number, was very small, so far as my experience goes. Though I saw a few dozen attracted into the house, thousands were within sight of the light and removed but a few rods; while for each of those thus attracted a dozen individuals belonging to other species came to the light. My own observation, then, goes to show that these moths are not attracted to any great extent by lights; but if this attraction should be proven to be considerable, this would prove one of the best ways of dealing with the pest.

On the whole, the conclusion at which we arrived in regard to the use of the lanterns is much the same as that which we have stated of poisoned sweets. Early in the spring and late in the fall they should be tried. Their use in the months between June and October will depend upon how efficacious other remedies have been, and upon the actual success of the trap used. In the seasons mentioned first, the planter must not be discouraged at the small proportion of cotton-moths to other moths, remembering the fact which we have so often reiterated, of the immense economic importance of every hibernating individual. It is well, also, to bear in mind that almost without excep-

tion the other moths which are thus captured are more or less injurious to vegetation.

In the special report we published figures and descriptions of many lanterns which have been patented. Our space will not admit of reproducing the figures and descriptions. Any planter can devise a trap which will answer the purpose. The principle is as follows: Place a light above a pan containing fluid, which may be either viscid or poisoned. The moths attracted by the light fall into the pan, and are thus destroyed.

THE BOLL-WORM.

IMPORTANCE OF THE SUBJECT.

Scarcely inferior to the cotton-worm in the extent of its injuries to the cotton crop is the so-called "boll-worm" (*Heliothis armigera*, Hübn.). Every year, and, it is almost safe to say, in every plantation in the whole cotton-belt this pest makes its appearance, and, although its ravages during some years are insignificant beside those of the cotton-worm, yet the *periodical* appearances of the latter, the confining of its hibernating area to the more southern portions of the cotton-belt, and its numerous parasites, all combine to render its superiority to the boll-worm as a cotton enemy very slight. There are, moreover, difficulties in the way of destroying the boll-worm—difficulties arising from its peculiar methods of work, and from the great number of its food plants—which do not exist in the case of the cotton-caterpillar, and which help to render the former as formidable as the latter. Indeed, in a large part of the cotton-belt there can be no doubt but that the boll-worm is the one by far the more to be feared. This is especially true in those more northern portions, which the cotton-worm reaches only late in the season; too late, generally, to do more than clear away the too abundant foliage, and allow the sun to ripen the bolls more quickly. Even in many parts of the more southern regions we find planters expressing the opinion that the boll-worm is the more to be dreaded of the two.

NATURAL HISTORY.

NOMENCLATURE.—Of popular names the boll-worm has one for almost every plant upon which it feeds and for every country which it inhabits; and as it is almost cosmopolitan and a very general feeder, these names are many. Throughout cotton-growing States it is very generally known as the *boll-worm* when it occurs upon cotton; when it occurs upon corn it is called the *corn-worm*, and as such it is known in those Western States in which it infests the corn crop. In many Southern States it is known in the early part of the season as the *corn-bud worm*. Where found upon tomatoes it is called the *tomato-worm*. These four names are the ones by which it is best known in this country. As we shall consider it only in its relation to cotton, we shall speak of it as the boll-worm, except where it is necessary to make use of one of the other titles.

GEOGRAPHICAL DISTRIBUTION.—The geographical range of the species is very great. Mr. Bond, at the March 1, 1869, meeting of the London Entomological Society, exhibited specimens from the Isle of Wight, Java, and Australia, and these localities, taken in connection with other parts of Europe and the United States, seem to justify a prediction made by Mr. Grote, that we shall probably soon write after its habitat—the world.

FOOD-PLANTS.—For many years it was not known that the destructive corn-worm and the cotton boll-worm were the same insect. It was suspected by many before actually demonstrated, but is even now unknown to the majority of agriculturists. The first record of the identity of the two insects which we have been able to find is in the Department of Agriculture Report for 1854, in an article headed "Insects infesting the cotton plant," by Townend Glover. Mr. Glover says:

There is a striking similarity between the boll-worm and the corn-worm, in appearance, food, and habits, both in the caterpillar and perfect state, which leads to the supposition that the boll-worm may be the young of the corn-worm moth, and the eggs deposited on the young bolls as the nearest substitute for green corn, and placed on them only when the corn has become too old and hard for their food. * * * Col. B. A. Sorsby, of Columbus, Miss., has bred both insects, and declares them to be the same; and moreover when, according to his advice, the corn was carefully wormed, on two or three plantations, the boll-worms did not make their appearance that season on the cotton, notwithstanding on neighboring plantations they committed great ravages.

To Col. B. A. Sorsby, then, must be given the credit for first making this important discovery.

The consideration of the boll-worm in corn is inseparably connected with the consideration of its work in cotton, so little more need be said here of its methods of work. In those corn States which do not grow cotton, it is greatly dreaded. Whole crops are ruined in Kansas, Kentucky, South Illinois, and Missouri, and scarcely a year passes without much damage being done.

According to Riley, there are two broods of the worms a year in those States, and very early and very late corn fare the worst, the intermediate varieties usually escaping severe injury. In seasons of protracted length, a third brood is sometimes produced, which, for want of other food, lives upon the hard kernels of well-ripened ears. Mrs. Treat has shown that an early brood in New Jersey bores into the stalks of corn, and also eats through the leaves surrounding the staminate flowers before the ears have begun to make their appearance. This would argue perhaps *three* broods a year north, making the exceptional late brood of which Professor Riley speaks a fourth. The so-called "bud-worms" of the Southern corn crop are nothing but this same early brood of *Heliothis*, having almost precisely similar habits to those observed in New Jersey by Mrs. Treat.

In the *rôle* of a tomato-worm, *Heliothis* has done a great deal of damage. In Maryland, in 1869, according to Mr. Glover, these worms did great injury to the tomato crop, eating alike the ripe and the unripe fruit, gnawing great holes in them and rendering them unfit for market use. One worm would sometimes entirely ruin a number of tomatoes on one plant alone. Concerning this taste of the boll-worm, Mr. Riley says:

This glutton is not even satisfied with ravaging these two great staples of the country, cotton and corn, but, as I discovered in 1867, it voraciously attacks the tomato in South Illinois, eating into the green fruit, and thereby causing such fruit to rot. In this manner it often causes serious loss to the tomato grower, and it may justly be considered the worst enemy to the tomato in that section of the country.

In the American Entomologist, ii, 172, we find the following interesting statement:

We learn from a recent number of Scientific Opinion that, at a late meeting of the London Entomological Society, Mr. Jenner Weir exhibited specimens of our cotton boll-worm moth (*Heliothis armigera*, Hübn.) which were bred from larvae which fed on the fruit of the tomato. As we have already shown (American Entomologist, i, pp. 212, 213), this same species attacks our corn, and does great damage to our tomatoes by eating into the fruit; and the fact of its being bred from the tomato in England, where this fruit is with difficulty grown, is interesting and suggestive.

But the tomato-worm is not confined to the fruit, as is shown by the fact that several specimens were recently sent to the department by Professor Willet with the remark that they were found boring into the terminal shoots of tomato plants at Macon, Ga., early in September.

Another common garden vegetable that is also injured by the boll-worm is the garden pea. This was observed by Mr. Trelease in Alabama. A boll-worm would bore a hole into the pod and devour its whole contents before leaving it for another.

Of allied plants, the boll-worm has been observed to eat the chick-pea (*Cicer arietinum*) in Europe, the common cow-pea of the South, and the common string-bean (*Phaseolus vulgaris*), and *Erythrina herbacea*, a leguminous plant common in the South. M. J. Fallou (*Insectologie Agricole*, 1869, p. 205) records *Heliothis* as feeding upon the chick-pea. He found the young worms to feed upon the leaves and the large ones to bore into the pod. With the cow-pea, upon which Mr. Trelease found it feeding very abundantly, and in which the pod is more fleshy and the pease separated by fleshy partitions, it often pursues a different course from that which it takes with the common garden pea; it often bores into one chamber of the pod, eats the seed in it, and then, instead of cutting through the partition to reach the next, bores another hole from the outside. The same observation precisely was made concerning their habits when feeding upon *Erythrina*. As to the string-beans, Professor Riley records that it was found eating them around Kirkwood, Mo., by Miss Mary Murtfeldt.

This department has also received specimens of the boll-worm from D. Landreth & Sons, of Philadelphia, as quite seriously infesting fields of Lima beans.

The pods sent were each pierced by one hole of an eighth of an inch or more in diameter, and the contents in every case had been destroyed.

Of other useful plants which the boll-worm occasionally feeds upon we would mention pumpkins (*Cucurbita pepo*) as recorded by Mr Glover in the Department of Agriculture Report for 1870, p. 84, and red peppers (*Capsicum annuum*), as recorded by G. H. French in the Seventh Report of the State Entomologist of Illinois, p. 162. Mr. Glover also states that "a young boll-worm was found in the corolla of the flower of a squash, devouring the pistil and stamens."

Mr. French also records the fact of finding what he considered to be the boll-worm in the pods of *Hibiscus grandiflorus*, the large flowered rose mallow.

Mrs. Treat discovered, in the course of her observations upon *Heliothis*, that many individuals of the first brood ate into the stems of the garden flower known as *Gladiolus*, and not only into the stems but into the flower buds also.

As regards its European food-plants, Professor Riley quotes from M. Ch. Goureau's *Insectes Nuisibles*, Second Supplement, 1865, p. 152, to the effect that it not only infests the ears of *Indian corn*, but devours also the heads of *hemp* and the leaves of *tobacco* and of *lucerne* (*Medicago sativa*).

And now let us turn to the consideration of the boll-worm on cotton.

THE EGG.

The egg of the boll-worm (Plate XVI, fig. 5,) moth differs in form from that of the cotton-worm moth, as shown in the accompanying figure, by its much greater diameter through from top to bottom, looking, as one author aptly expresses it, "as though molded in a tea-cup,

while the cotton-worm egg was molded in the saucer." The two diameters of the egg are nearly equal and are about the same as the greatest diameter of the egg of *Aletia*. In color also it differs from the egg of *Aletia*, the latter being of a delicate green, scarcely distinguishable from the leaf, while the former is nearly white and easily detected upon the plant. A noticeable feature of many of these eggs is an irregular reddish-brown band near their summits, which gradually disappears with the development of the embryo. The sculpturing of the egg is almost identical with that of the cotton-worm moth. The number of eggs laid by the female *Heliothis* must approximate pretty closely to that laid by the female *Aletia*. According to Mr. Glover, a single female boll-worm moth dissected by Dr. John Gamble, contained upwards of 500 eggs. From their greater thickness, this number of eggs would necessarily take up more room than the same number of *Aletia* eggs, and hence we find that the female *Heliothis* is more robust than the *Aletia*.

From all accounts, the favorite ovipositing time is at or shortly after twilight, when the moths are flying in great numbers. Concerning the place of deposit of the eggs, however, published accounts have differed. Mr. Glover says:

> The egg is generally deposited singly on the outside of the involucel or outer calyx of the flower or young boll, where it adheres by means of a gummy substance which surrounds the egg when first laid, and which hardens by exposure to the atmosphere. It has been repeatedly stated by planters that the egg was deposited on the stem, and that the young stem forms the first food of the newly-hatched caterpillar; but after a careful examination of several hundred stems I found only one egg placed in this situation, and that, from the fact of its being laid on its side instead of the base, had evidently been misplaced.

Professor Riley, in his Third Missouri Entomological Report follows Mr. Glover quite exactly, saying: "It is usually deposited singly on the outside of the involucre or outer calyx or young boll."

Observations made during the past two years would seem to disprove this statement of Mr. Glover pretty effectually. I found it to be the exception that the eggs are laid upon the involucre. Although I have found them upon all parts of the plant, the majority of them seem to be deposited upon the lower surface of the leaves, as is the case with the cotton-worm eggs. I made a careful search of many plants while in the cotton fields of Alabama, and the following note will serve to indicate the usual distribution of the eggs: "On one plant I found eleven eggs which were distributed in the following manner: one on the involucre, two on the stalks, and eight on the leaves." Mr. Trelease states in his report that he found them upon the petioles and both surfaces of the leaves, and upon the outer surface of the involucre.

The duration of the egg state varies with the season of the year, much as it does with the egg of the cotton-moth. We have no data as to the actual length of time between the laying of the egg and the time of hatching, but it probably approximates to *Aletia* in this respect, although the time may be somewhat longer.

THE LARVA.

As just stated, we have disproved the old idea that by far the majority of the eggs are laid upon calyx and involucre, and it consequently follows that the received opinions as to the newly-hatched worm boring immediately into the boll or flower bud must also be thrown aside. The worm after gnawing through its egg shell makes its first meal upon the part of the plant upon which the egg was laid, be it leaf, stem, or invo-

lucre. Should it be laid upon the leaf, as is usually the case, it may be three days before the worm reaches the boll. Should it be laid upon the involucre, the young worm bores into the boll at an earlier date. As a rule, we may safely say that where the egg is laid upon the involucre the worm pierces through within twenty-four hours after hatching.

The newly-hatched boll-worm walks like a geometrid larva or looper, "a measuring worm," as it is often called. This is easily explained by the fact that, while in the full-grown worm the abdominal legs or pro-legs are all nearly equal in length, in the newly-hatched worm the second pair is slightly shorter than the third, and the first pair is shorter and slenderer than the second, a state of things approaching that in the full-grown cotton-worm, though the difference in size in the former case is not nearly so marked as in the latter. This method of walking is lost with the first or second molt. There is nothing remarkably characteristic about these young larvae. They seem to be somewhat thicker in proportion to their length than the young cotton-worms, and they have not so delicate and transparent an appearance. Their heads are black, and their bodies seem already to have begun to vary in color. The body above is furnished with sparse, stiff hairs, each arising from a tubercle. I have often watched the newly-hatched boll-worms while in the cotton fields. When hatched from an egg which had been deposited upon a leaf, they invariably made their first meal on the substance of the leaf, and then wandered about for a longer or shorter space of time, evidently seeking a boll or flower-bud. It was always interesting to watch this seemingly aimless search, the young worm crawling first down the leaf stem and then back, then dropping a few inches by a silken thread, and then painfully working its way back again, until at last it found the object of its search, or fell to the ground, where it was destroyed by ants.

We may safely say, then, that the young larvae feed for a longer or shorter space of time upon the part of the plant on which they are born, but usually migrate sooner or later to flower-bud or boll. That the worm may occasionally attain full growth, having fed upon the leaves alone, is suggested by the fact that Mr. Trelease, on May 30, found a partly grown boll-worm feeding upon the leaves of cotton. At this time the forms were very few and very small. Comparatively early in the season, when feeding upon buds or small bolls, a single worm often does a great amount of damage, proceeding from bud to bud or from boll to boll.

The destruction of the essential parts of the flower before the boll proper is formed, is sometimes as great a source of loss as the destruction of the maturing bolls.

It is quite a common sight to see large worms in the flower, as also the younger individuals, the latter, however, usually having penetrated the bud and forced the premature blossom.

As the boll-worms increase in size, a most wonderful diversity of color and marking becomes apparent. In color, different individuals will vary from a brilliant green to a deep pink or a dark brown, exhibiting almost every conceivable intermediate stage, and from an immaculate, unstriped specimen to one with regular spots and many stripes. The green worms are more common than those of any other color; but those of varying shades of pink or brown are so abundant as to make it impossible to fix upon a type. Early in the season (as will be hereafter shown) the prevailing color is green. A common variety is light green in color. Running from the first ring back of the head to the posterior end of the body on each side is a broad whitish line; just above is a broad dusky

line; down the center of the back is another dusky line, or stripe, as it should preferably be called; this dorsal stripe has a narrow white line down its center, and it is bordered on each side by a narrow white line. Between the dusky dorsal and lateral stripes run four or five very faint, wavy, longitudinal, white lines, so faint as not to interfere with the general color of the body. Each body-ring has eight black spots, which, upon being examined with a lens, are seen to be tubercles, each with a stiff hair upon its tip. These spots are arranged in two transverse rows of four, the spots in the front row being slightly closer together than those in the back row; the outer spot of the back row is small and placed nearer the front row.

Of these features the most constant seems to be the whitish stripe on each side. When the boll-worm is brown these stripes assume a yellowish hue. They are shown in all illustrations of the boll worm yet published, and are present in all specimens in the department collection. Another pretty constant feature is the relative position of the tubercles just described. They are not always of a contrasting color to the rest of the back, and hence cannot always be spoken of as spots. When they are not discernible as spots, however, an examination with the lens shows them still present as tubercles, each surmounted by a hair. This point affords apparently a good and reliable means of distinguishing the young boll-worm from the young cotton-worm, which otherwise might prove a matter of difficulty during the earlier stages and in the early part of the year, before black cotton-worms are to be found. In the cotton-worm the two middle spots of each of the two rows of four are of the same distance apart, so as to form the four corners of a rectangle. In the boll-worm, however, the two middle spots of the hind row are more widely separated than the corresponding spots of the front row. This distinction may be recognized at a glance when the eye has become accustomed to it. The dusky dorsal stripe is often wanting, as also are the dusky lateral stripes, and, as just stated, the spots are often indiscernible.

Mrs. Treat seems to have noticed a uniformity of color as between individuals of the same brood, and a diversity as between those of different broods. She says:

I did not think that this green larva that eats into the pease and stalks of corn, before the latter are half grown, was, as you inform me, this same striped boll-worm that eats into the ears of corn. * * *

Such uniformity depending upon brood, or diversity from diversity of brood or food-plant, can by no means be laid down as a rule. The early brood, however, seems to consist almost entirely of green individuals, and those feeding upon other plants than corn and cotton are more usually green also. The pink individuals are more common upon cotton and the roasting-ears of corn. As Mrs. Treat has stated, a green worm may turn brownish after the later molts, but *half*-grown brown worms are very abundant in the bolls of cotton. In this connection, Mr. Glover states:

These variations of color are not easily accounted for, as several caterpillars changed color without any apparent cause, being fed upon the same food and in the same box with others. Several planters assert that in the earlier part of the season, the green worms are found in the greatest number, while the dark brown varieties are seen later in the autumn, as we know is also the case with the caterpillars of the cotton-worm.

We have shown elsewhere that the larva of *Heliothis* has one redeeming character in its occasional cannibalistic and predaceous turn of mind. Boll-worms, when in confinement, have the habit, in common with other

lepidopterous larvae, of devouring one another. All through the past summer larvae were being sent to the department from the South, but whenever several boll-worms were mailed in the same box, one only would reach us alive, all the others having been destroyed. This was the case even when the box was filled with cotton leaves and bolls or corn leaves. It might, however, be said that the food dried up on the journey, and that hence they were driven to destroy one another; but the fact is that even when confined in breeding cages, where fresh food was always at hand and where the conditions were made as natural as possible, they seemed as hungry as ever for their companions, and it was impossible to rear more than one in the same box or cage.

Still more conclusive, however, and of extreme interest, is the fact that Mr. Trelease actually saw, upon several occasions, on the plant and undisturbed, large boll-worms catch smaller ones, which they devoured "hoof and hide," or simply pierced the skin with their mandibles so that the juice could be sucked, the refuse being dropped.

In addition to this we have the fact fully established during the past season that the boll-worm, in a state of nature, preys more or less frequently upon the chrysalis of the cotton-worm.

In the specimens sent to the department, the full-grown boll-worm was found entirely within the folded leaf and the hind end of the body of the chrysalis was eaten into.

Judging from the data at hand, the duration of the larva state of *Heliothis*, or, in other words, the *worm state*, seems to vary from eighteen to twenty-four days in the cotton-belt, depending much upon the climate, the state of the weather, and the food plant. When full-grown it transforms to a chrysalis, with very different preliminaries from those which prepare the cotton-worm for pupation.

THE CHRYSALIS.

Almost all of the statements regarding the pupation of the boll-worm have been to the effect that the full-grown worm descends into the ground to the depth of several inches, and there forms itself an oval cocoon of gravel and earth, cemented together by its gummy silk.

Prof. G. H. French, of Illinois, has studied the chrysalis of *Heliothis* carefully of late, and sums up his observations as follows:*

> In digging for the chrysalis around the corn-hills, I found that instead of their occupying an oval earthen cocoon, as has usually been written of them, and as they apparently do in the breeding box, they were down in the ground from five to six inches below the surface, in a hole about a third of an inch in diameter, reaching from the chrysalis to the top of the ground, where it was covered with a thin film of dirt from an eighth to a quarter of an inch thick. This hole was larger at the bottom than at the top, apparently so as to give full motion to the chrysalis, and usually bent in its course, so the lower part would have an inclination of perhaps forty-five degrees. At the bottom would be found the chrysalis, the small end downward and the head upward. In one case I found the hole so bent that the chrysalis occupied a horizontal position. The hole was smooth inside, and was, perhaps, made so by cementing the earth together, but of that I could not tell, for the whole ground was moist, though dry enough to be firm.

In reference to these observations of Professor French, Mr. Trelease says, in a recent letter:

> In deep breeding-jars, with four or five inches of loose soil, I found that the larvae of *Heliothis* went several inches from the surface before forming their cocoon, but did not notice a passage leading down. As I did not notice very closely, such a tube may have been there, but I think if so I should have seen some trace of it. In all cases there was a thin film of silk. In the field I saw numbers plowed up, but did not dig for any with care. Of course the plowing would have destroyed such a tube, but I sometimes found the silk about the pupa, though always more or less torn.

*Seventh Report of the State Entomologist of Illinois, 1877, p. 105.

The rearing of boll-worms at the department would seem to show that in loose, friable earth the passage made by the worms in their descent becomes obliterated by the falling together of the earth behind them; but it seems probable that, in compact soil, any larva entering the ground would leave a round passage behind it. A thin film of silk has always been noticed lining the cell in which the chrysalis is found.

In addition to the prominent distinguishing point that the chrysalis of *Aletia* is invariably found only above ground, and is normally found in rolled leaf and slight cocoon, while the chrysalis of *Heliothis* is invariably found only below the surface of the ground, normally in a smooth shell, lined with a thin film of silk, it may be well to mention the characteristic points which distinguish the chrysalides themselves.

The pupa of *Heliothis* is reddish or light brown, and polished, and the pupa of *Aletia* dark brown, sometimes almost black, with the lower margin of the abdominal rings, 4 to 6, of a reddish-yellow or saffron color; it is not polished, but has a greasy appearance. The pupa of *Heliothis* is rather stout, and the last segment is rounded and furnished with two slender, straight spines (Plate XVI, fig 6). The pupa of *Aletia*, contrary to this, is quite slender, especially the abdomen; the last segment is not rounded, and its tip is prolonged into a tail-like appendage, which bears at the tip 4 spines, the ends of which are curved so as to form a loop; four similar spines are placed transversely in a row, a little in front of the terminal 4 hooks; this makes eight spines for *Aletia* and only two for *Heliothis;* the stigmata or breathing-holes are rather conspicuous on the pupa of *Heliothis*, and scarcely noticeable on the pupae of *Aletia*.

We insert a detailed description of the chrysalis of the boll-worm for the benefit of those interested:

Heliothis armigera.—Pupa: Length, $\frac{7}{8}$ to $1\frac{1}{8}$ of an inch; color, reddish brown, darker towards the head; polished. The following particulars will be noticed when examined under the microscope: the head, which narrows in the region of the maxillae to a rounded, somewhat elevated ridge, is covered with minute and rather indistinct granulations, and has near the front a few shallow, transverse, impressed lines, which, however, do not entirely cross from one side to the other; there are also a few irregular impressions on the head behind the eye, and about midway between the posterior angle of the eye and the posterior margin of the head is an impressed puncture from which a very short stiff hair arises, and another shallow impression somewhat in the shape of a V may be found at the middle near the posterior margin; the sculpture of the thoracic segments is somewhat different from that of the head; the whole surface is closely and very finely faceted, and quite a number of irregular, shallow, impressed transverse lines run over the whole surface; the 3d ring is very much wrinkled; the surface of the abdominal rings is similarly sculptured; the front margin of rings, 4–7, is coarsely punctured; the 4th has only few of these punctures, but on the other three rings they are quite numerous around the whole margin; the front portion of these punctures is deep, and they run out posteriorly more or less into a shallow, channel-like impression; the posterior margin is covered quite regularly with slightly elevated, dark brown granules of different forms; some are square, others five, and others six-sided; the other rings, except the last, have nothing peculiar in their structure; the last segment is bluntly rounded, and furnished at the ends with two quite long, black, slender spines, which at their apical third are whitish, faintly bent upwards, with their tips sometimes slightly twisted and directed downward; ventrally, this ring and the one before it have each a short, longitudinal impressed line; the circumference of the stigmata is elevated, dark brown, with the center of a sandy color and spongy texture; the cases of the wings, legs, and antennae are covered with shallow facets.

THE MOTH.

After the figure of the moth on Plate VIII, an additional extended description will be unnecessary. It is a very variable species, and it is owing to this fact that American specimens were so long consid-

ered to form a species distinct from the European. In size the variation is not great, the smaller individuals having an expanse of wing of an inch and three-eighths, and the larger ones expanding an inch and three-quarters. The general color of the body and upper wings varies from a light gray tinged with olive green to a rich yellow gray, almost tawny. In some specimens the markings of the fore wings are almost obliterated, and in others they appear with great distinctness. On the hind wings there is much variation in the size of the light spot within the dark band; in some specimens it is not discernible, and in others its length equals half the breadth of the wing. The width of the black band of the posterior wings also varies greatly. The moth is so very different from *Aletia* that even a hasty glance at the plates will enable the planter to distinguish them. The most prominent distinguishing feature, and one that can be recognized at a glance, is the broad black band on the hind wings of the boll-worm moths. When at rest the latter does not tightly close its wings roof-shaped over its back, as does the cotton-worm moth, but holds them slightly open, so that the black band is plainly seen.

The moths begin to fly shortly after sundown. During the day, when disturbed, they fly out with the quick darting motion peculiar to most noctuids under such circumstances—a flight almost precisely like that of the cotton-moth. At night, however, their flight is freer and more sustained. As has been noted of the adult *Aletia*, these moths feed at night upon the nectar secreted by the glands of the cotton-plant, the cow-pea, the greater coffee-weed, and probably upon others. Their methods of feeding are almost precisely like those of the cotton-moth, the antennae being kept in constant vibration. They also, upon occasion, hover before a gland, steadying themselves by their fore legs. When at rest and sucking nectar, they do not fold the wings like *Aletia*, but keep them slightly raised and partly open. We have not heard of this moth being found to feed upon fruit as *Aletia* does, though it is probable that this may occur, as the tip of the proboscis is spined in a somewhat similar manner.

THE NUMBER OF BROODS.

The chrysalis of the boll-worm usually gives forth the perfect moth in early May in the more southern portions of the cotton-belt. The eggs of these first moths are for the most part laid on the leaves of corn, though occasionally one is deposited upon the just-appearing cotton plant, and others are laid upon the other food-plants to be found. By far the majority are laid upon the corn leaves; and it is a rare occurrence to find a boll-worm upon *cotton* in the months of May and June. The individuals of this first brood of *Heliothis* upon corn are called, in many parts of the South, "terminal bud worms," the reason for which will shortly be shown.

The newly hatched larvae begin feeding at once upon the corn leaves upon which they were born, and gnaw many small irregular holes through them, giving them the appearance of having been riddled by a charge of small shot. Upon these external leaves of corn they may be found for some time, specimens upwards of half of an inch in length having been collected May 21. As they increase in size they progress downward into the closely folded leaf, and sooner or later reach the tender terminal leaves or bud, where they do a very destructive work.

The plants thus infested may be readily recognized by the riddled appearance of the larger leaves. When such a stalk is found, if the leaves,

beginning with the outermost, be stripped off nearly to the bases of their sheaths, a quantity of brown, dry excrement will be found, increasing in quantity as the center of the plant is approached, until at last the usually pale green worm is reached, either within the sheath of a leaf or in a cavity eaten into the closely rolled terminal leaves. When full grown, it gnaws a circular hole through the leaves directly outwards from the point where it has been feeding and falls to the ground, where it transforms to a chrysalis, as before described.

It is difficult to estimate the usual amount of damage done by the first brood, as it differs so much in different localities. It seems, however, never to be alarmingly great, on account of the comparatively small numbers. Observations on a small scale in Alabama showed about one plant in forty to be infested by them.

A second brood makes its appearance in Alabama from the first to the middle of June. The eggs are, as before, for the most part laid upon the corn leaves. Some few are laid upon cotton—more, usually, than is the case with the first brood. The young larvae feed upon the leaves as before and upon the tassels. As they approach full growth they are found within the young ears, feeding upon the silk, the milky kernels as fast as they appear, and upon the tender cob. Upon reaching full size they bore through the shuck and fall to the ground. The moths of this second brood may be seen flying in considerable numbers in the early part of July.

It is the next, the third brood proper, which does most damage to corn. This is called the "corn-worm," the "ear-worm," or the "tassel-worm." About the 1st of July the eggs are laid, probably near the end of the husk of corn. Very few eggs are laid upon cotton growing in the same field. The larvae feed upon the silk and tender grains near the ends of the ears, destroying many ears and rendering many others unfit for use. It is a noticeable fact that, while the individuals of the two earlier broods have for the most part varied little in color, being chiefly of a pale green, this third brood consists of worms of the various shades of green, pink, and rose. These larvae attain full growth probably in the shortest time of any of the broods, and boring through the husks fall to the ground to pupate as before.

By the 1st of August or thereabouts, when the time for a fourth brood has arrived, the ears of corn have begun to harden, while cotton bolls and forms are very plentiful. Instinct teaches the moths of the third brood to lay their eggs upon cotton instead of upon corn, as their parents have done. We have mentioned the fact that a few worms are to be found upon cotton previous to this time. An occasional individual will be found to have attained his growth on cotton in May, before a flower-bud has appeared, and which has evidently fed entirely upon cotton leaves.

Mr. G. W. Hazard, of Rutledge, Ala., makes the statement: "Bud-worms injure the cotton while very young, in cool wet springs, generally in the last of April and through May."

Mr. Trelease found the first larvae eating the flower-buds or forms as early as June 11; but very few were found from this time on until the appearance of the fourth brood upon cotton, thus demonstrating plainly that a corn diet is much preferred so long as certain tender portions can be obtained.

The habits of this fourth brood have already been given in the general remarks concerning the boll-worm upon cotton. It is by far the most destructive brood. About the 1st of September the moths of this

brood are to be seen in great numbers at night sucking the nectar of cotton, cassia, and cow-pea.

The fifth brood begins early in September, and is also confined to cotton. In all but the most southern portions of the cotton-belt this brood appears normally to be the last, its chrysalides living through the winter in their underground cells. With an exceptionally fine season it seems probable that there may be another brood, but upon this point we have, as yet, no evidence.

These remarks upon the number of broods are based upon observations made the present year in Central Alabama, and the following facts must be taken into consideration: that the observations were limited geographically to a single point, central, it is true, but were unconfirmed by observations from other points. Moreover, 1879 was by no means a bad worm year. From opposite extremes of the cotton belt we should expect to find variation in opposing directions from this as an average. In years when the worms were very numerous we should expect to find them infesting cotton at a period earlier than that which we have designated, and where corn is not grown in the vicinity, they probably feed upon cotton from the first appearance of the flower-buds. These points will account for the fact of the frequent *early* reports of the ravage of the boll-worm in cotton.

The same difficulty also arises in ascertaining the precise number of broods of the boll-worm that was found with the cotton-worm. Some moths issuing from winter quarters later than others, or failing so soon to find a suitable place of deposit for their eggs, will lay their eggs later than others. Some larvae, moreover, may, by surrounding circumstances, fail to develop as fast as others. These and other points combined start an irregularity of the broods, the tendency of which is to continually increase rather than to diminish, until in the later generations upon cotton we may find them in all stages at once—eggs, larvae of all sizes, chrysalides, and moths. The number and relative appearances of the broods normally, however, we believe to be that which we have given.

The boll-worm disappears in the fall before the cotton-worm does. Mr. G. W. Smith-Vaniz, of Canton, Miss., gathered eggs from one of which a larva hatched August 30. It became a chrysalis September 22, and passed the winter in this state, issuing as a moth May 14. Another brood of the cotton caterpillars was reared after this boll-worm went into winter quarters.

In his Third Missouri Entomological Report, p. 107, Professor Riley makes the statement:

> Most of the moths issue in the fall and hibernate as such, but some of them pass the winter in the chrysalis state and do not issue till the following spring. I have known them to issue, in this latitude (38½° N.), after the 1st of November, when no frost had previously occurred.

It may be true that *Heliothis* occasionally hibernates as a moth. No instance of such hibernation has, however, come under our notice, nor do we find any other statement of this fact than this of Professor Riley's, just quoted. It is certain that the insect normally hibernates in the chrysalis state, and that if a hibernating moth is found it is an exceptional occurrence.

Many of the noctuidæ hibernate as moths, and some, as, for instance, the army-worm of the north (*Leucania unipuncta*, Haworth), are supposed to winter either in the moth or chrysalis state. The latter point is not yet definitely settled, however, and even if it were it would simply create a precedent, not necessarily a probability, in favor of a dual hibernation of *Heliothis*.

INFLUENCE OF WEATHER.

It seems to be a pretty generally-settled point among planters, so far as we can ascertain, that the boll-worm is influenced by the weather in a similar manner to *Aletia;* that is to say, that they flourish best in wet seasons, and in dry, sunshiny weather do least damage. The testimony on this point is hardly as unanimous as with the cotton-worm, but it is sufficiently so to enable us with justice to make the general statement. Mr. Trelease says in this connection:

> Like the cotton-caterpillar, the boll-worm is more abundant in wet than in dry places; at least such was my experience, and it is also said to do better in wet than in dry seasons. This is readily explained by the hostility of ants, which are more abundant in dry than in wet places, and in fair than in rainy seasons.
>
> Early in June several half-grown "bud-worms" were collected on Indian corn and transferred to cotton-plants with a view to watching their actions. Care was taken to place them upon plants upon which there were no ants. Seating myself beside them, I awaited developments. At first they evinced no desire to do more than conceal themselves beneath the leaves from the glare of the sun. But it was not long before a stray ant appeared on the plant, and, finding the larva, proceeded to run round and round it, biting it whenever it could.
>
> Soon, however, finding that unaided it could do little, the ant left the plant, and, after watching it a short time, I lost sight of it; but in a few minutes it returned accompanied by several others of the same species. In a little while the worm was so worried that it fell from the plant, and was soon killed and carried off by its tormentors, which followed it to the ground.
>
> Several times I saw this repeated, the boll-worm being killed in each case within an hour after the time when they were placed on the cotton. Ants were also seen to kill these larvae upon several occasions, and once or twice when the worms had not been interfered with by me.

Mr. Lyman, in Department of Agriculture report for 1866, says that many eggs of the boll-worm moth are destroyed by ants.

The theory of the ants influencing the comparative abundance of worms in wet and dry weather is, as we have said before, an extremely plausible one if its basis be correct. There cannot be the slightest doubt but that ants abound upon dry soil rather than upon that which is moist, and in dry, sunshiny weather rather than in rainy weather; nor can there be the slightest doubt but that many species destroy both cotton and boll worms. Then the theory will hold just so far as this destruction goes—just to the extent that the ants kill the worms. The fact that there is a slight difference of opinion as to the influence of the weather can then be easily explained by the comparative abundance of ants in different localities. The theory does not, however, entirely account for facts as observed, but will have to be taken in connection with the nectar-gland theory, and also with the facts of the superior nourishing power of a tender and succulent plant, as compared with one dry and dwarfed from drought.

REMEDIES.

NATURAL REMEDIES.

The remarks already made (see page 305), concerning the efficacy of insectivorous birds and of predaceous insects will apply equally well here. Strange to say, but one parasite upon *Heliothis* has been found. This was bred from a chrysalis received September 15, 1879, and proved to be *Tachina aletiae.* (See page 302.)

Professor Riley, in a foot-note in his fourth Missouri report, mentions *Heliothis armigera* as being among the species from which he had bred *Tachina anonyma.* (For the habits of the Tachina flies see page 302.)

As to actual observations upon birds, Mr. Glover says:

Insectivorous birds also serve as very useful agents in the diminution of the boll-worm. In proof of this fact I will state that I have seen a king-bird, or bee-martin chase and capture a boll-worm moth not ten paces from where I stood, and which I was in pursuit of at the same time; also, that some young mocking birds, kept in their nest near an open window, were fed daily by their parents with insects, among which were quantities of the boll-worm moth, as was proved by the ground underneath being strewn with their dissevered wings.

As to predaceous insect enemies, we have already referred (see page 343) to the most effective—the ants—and further discussion will be unnecessary. Of the others, those doing most good will probably be the wasps, the asilus flies, the devil's coach-horses, the lady-bird larvae, and the golden-eyed lace-wing fly larvae. The ground-beetles will play a more important part, in all probability, in destroying the boll-worms than they do in destroying the cotton-worms, on account of the former descending into the ground to pupate.

Mr. Glover gives an account of a spider which is said to destroy the boll-worm, in the following words:

Another description of a small spider, about the tenth of an inch in length, of a light drab color, with two or more dark spots on its back, was found very numerous inside of the involucre or ruffle of the cotton-bloom, where it is said to be useful to the planter in destroying very young boll-worms. In many cases, where the eggs of the boll-worm moth had been deposited and hatched out, and the young worms had eaten through the outer calyx and already pierced a hole in the young bud or boll, it was frequently observed that no worm could be discovered inside; but, upon opening such a ruffle, this small spider was almost invariably found snugly ensconced in its web; hence it was surmised that the young worm had entered between the ruffle and the boll or bud, and had been destroyed by the spider, the nest of which was found in such situations.

ARTIFICIAL REMEDIES.

TOPPING.—Topping the cotton at a certain time of the year has been urged as a means of destroying the eggs both of the cotton-worm and boll-worm moths. It has already been shown that this would not prove efficacious as a remedy for the cotton-worm, and the result would be the same with the boll-worm. It is true that some eggs would be destroyed in this way, but actual count has shown that the destruction of those eggs which are deposited upon the upper part of the plant would not pay for the labor of topping.

POISONING.—It has always been said that the strong point of the boll-worm lay in the fact that it worked within the boll, where no poison could reach it, and that this method of destruction would prove of no avail. Our study of the habits of the insect has shown us, as before stated, that by far the greater number of the eggs are laid upon the leaves, and that the newly-hatched larvae, before migrating to flower-buds or bolls, almost invariably feed to a greater or less extent upon the leaf where they were born. This shows, then, that a well-distributed poisonous mixture would, in all probability, destroy great numbers of the young worms. Observation has also shown that well-grown boll-worms, migrating from boll to boll, are also frequently killed by eating poisoned leaves. There is, then, a double reason for poisoning worm-infested cotton. The proper time for poisoning for the boll-worm, in regions where there is reason to suspect an extensive migration from corn to cotton, is a few days, say a week, after the full-grown worms are found in the hardening ears of corn, or when the moths are observed to fly abundantly after the ear has begun to harden. The poisoning for the third brood proper of the cotton worm and of the boll-worm can be done simultaneously.

Inasmuch as an extended discussion of poisons and methods of applying has been given in that part of the report relating to the cotton-worm, any remarks on this head will be unnecessary.

HAND-PICKING.—We should be far from advising any planter to attempt to rid himself of the boll-worm by collecting them from *cotton* by hand. The plan which we do mean to suggest under this heading is killing the earlier brood of the insect upon corn as a preventive against future injuries in cotton.

This idea was first suggested by Col. B. A. Sorsby, as stated in the Department of Agriculture Report for 1855:

> Col. B. A. Sorsby, of Columbus, in Georgia, has bred both these insects (corn and boll worms) and declares them to be the same; and, moreover, when, according to his advice, the corn was carefully wormed on two or three plantations, the boll-worms did not make their appearance that season on the cotton, notwithstanding that on neighboring plantations they committed great ravages.

Mr. E. Sanderson, in 1858, having come to the conclusion that the two insects were identical,* advised the early planting and forcing of cotton, and the late planting of alternate rows of corn, with the view of keeping the worms supplied with a stock of the food-plant which they evidently preferred.

In 1859, Mr. Peyton King, of Enterprise, in commenting upon Mr. Sanderson's paper, said:

> If they are the same, their ravages may be to a great extent lessened by the plan suggested by Mr. Sanderson—that of planting the corn crop later. And to his plan I would suggest another—that of sending hands at the proper time through the corn for the purpose of opening slightly every ear with a dead silk, to extract and destroy the worm, and thereby destroy the miller. This might pay in reference to the corn alone.†

No attention seems to have been paid to either of these suggestions, and the remedy has never come into use.

The same idea suggested itself to me during my stay in the field in the summer of 1878, but, as I arrived in the latter part of July, I was only able to theorize. Mr. Trelease was instructed to pay attention to this point, and in his report we find the following:

> Since the earliest broods of larvae are found on the maize, or Indian corn, first in the stalk, later in the ears, and since the tendency of the species to multiply in geometrical progression makes it desirable to destroy the early broods if possible, I would suggest hand-picking of these earlier broods as the best way known to me of dealing with the pest. As was stated when speaking of the natural history of *Heliothis*, if one of these larvae has taken up its abode in a stalk of corn, the fact can be detected by a very superficial examination, owing to the holes formed in the leaves. Let, then, each plow-hand be instructed, when cultivating the corn, to stop whenever he finds such a stalk, and catch and kill the worm, even though it should occasionally be necessary to destroy the plant in doing this, for the hill may be replanted, and the larvae thus killed might, if suffered to live, become in a few generations the parent of hundreds of boll-worms. Later, after the corn is laid by and has begun to fruit, boys may be sent through the fields to kill the "tassel-worms," the presence of which may be detected by the excrement at the end of the ear or by the silk being eaten away. To catch these it will be only necessary to open the husk for a short distance back from the end of the ear, and, from the ease of discovering affected ears, the expense will not be great. It is objected to this that ears so opened are exposed to the weather and to the attacks of birds. Though it must be admitted that this is true to a certain point, the destruction of all ears so interfered with does not follow, and the great lessening of the next crop of boll-worms will, I am certain, more than pay for what corn is sacrificed.

The boll-worm cannot be expected to be exterminated by this process, since it has so many other food-plants from which it could, at any time,

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*American Cotton Planter, November, 1858.
†*Ibid.*, February, 1859.

migrate to corn or cotton; but, inasmuch as corn appears to be its favorite food, its numbers could be very greatly lessened, and its injuries to cotton could be almost done away with by this process. We advise planters by all means to try it, and we assure them that their time will not be lost. In sections of the cotton-belt which are badly troubled with the boll-worm, and where corn is not grown, it will be well to plant the latter crop and use it as a trap, as advised above.

ROTATION OF CROPS.—In the light of the relation of the corn and boll worms, and of the numerous food-plants of *Heliothis*, we may here mention the fact that rotation of crops has been strongly urged as a preventive against the ravages of the boll-worm. The knowledge which we have gained of the multivorous habits of the insect readily shows us that such a course would be vain, as during the season when cotton was not grown some other food-plant would be available. As a curiosity, we may mention the fact that some years ago a writer in the Southern Cultivator, after earnestly urging rotation of crops, advises *corn as the best crop to rotate with cotton!*

DESTRUCTION OF THE CHRYSALIDES.—In the more southern portions of the cotton-belt, where the frosts are rarely severe, but little can be done toward the destruction of the chrysalides beyond instructing the plow-hands to crush them whenever they observe them in plowing, or causing a boy to follow the plow and collect them as they are brought to the surface. In the more northern portions, however, *fall plowing* may accomplish much good. Experiments, having the testing of the efficacy of this remedy in view, have been made by Professor French. We can do no better than to give his own words:

Fall plowing.—To make it plain how this is to reach them, I shall have to explain some observations made on the fall brood of chrysalides that were found during the month of November in a field where the worms had been very abundant in the corn before it was harvested. In digging for the chrysalides round the corn-hills, I found that instead of their occupying an oval earthern cocoon, as has usually been written of them, and as they apparently do in the breeding-box, they were down in the ground, from five to six inches below the surface, in a hole about a third of an inch in diameter, reaching from the chrysalis to the top of the ground, where it was covered over with a thin film of dirt from an eighth to a quarter of an inch thick. This hole was larger at the bottom than at the top, apparently, so as to give free motion to the chrysalis, and usually bent in its course so that the lower part would have an inclination of perhaps forty-five degrees. At the bottom would be found the chrysalis, the small end downward and the head upward.

In one case I found the hole so bent that the chrysalis occupied a horizontal position. The hole was smooth inside, and was perhaps made so by cementing the dirt together; but of that I could not tell, for the whole ground was moist, though dry enough to be firm. I took several of the chrysalides and put them in a box with some loose dirt, and then moistened it, after which I allowed them to freeze. The dirt, when they were allowed to freeze, was dry enough, so that if it had been in the garden and turned over with a spade it would crumble. When examined, after the freezing, all were dead. Some others, taken up in the bottom of their subterranean habitations, without sifting the loose earth round them in their holes, and allowed to freeze, were not killed by freezing.

My conclusions were, that so long as they were in the smooth compartments they had made for themselves, free from any loose dirt that would become wet and stick to them, they could pass the winter in safety, even though they might be frozen; but, when the dirt was packed loosely round them and became wet and stuck to them, then freezing killed them. Their holes, running cell-like as they do from the surface down into the ground five or six inches, must be broken up by plowing, and when once broken up with the loose dirt round them the rains and the freezing winter weather would have the same effect on the chrysalides that moisture and freezing had on those in the box of loose dirt. Fall plowing, then, for these reasons, will probably be the most efficient means of destroying these insects; besides, if done late enough, it will rid the ground of cut-worms, &c.

DESTRUCTION OF THE MOTHS.—It is the general opinion throughout the South that the best if not the only way of getting rid of the boll-

worm is by the use of lights and poisoned sweets for attracting the moths. Several correspondents even go so far as to say that the ravages of the worms can always be checked by attracting the moths with lights. Colonel Sorsby always had great success in killing these moths with molasses and vinegar. He says:*

We procured eighteen common-sized dinner-plates, into each of which we put half a gill of vinegar and molasses, previously prepared in the proportion of four parts of the former to one of the latter. These plates were set on small stakes or poles driven into the ground in the cotton-field, one to about each three acres, and reaching a little above the cotton-plant, with a six-inch square board tacked on top to receive the plate. These arrangements were made in the evening, soon after the flies had made their appearance; the next morning we found eighteen to thirty-five moths to each plate. The experiment was continued for five or six days, distributing the plates over the entire field, each days' success increasing, until the numbers were reduced to two or three moths to each plate, when it was abandoned as being no longer worthy of the trouble. The crop that year was but very little injured by the boll-worm. The flies were caught in their eagerness to feed upon the mixture by alighting into it and being unable to escape. They were probably attracted by the odor of the preparation, the vinegar probably being an important agent in the matter. As the flies feed only at night, the plates should be visited late every evening, the insects taken out, and the vessels replenished as circumstances may require. I have tried the experiment with results equally satisfactory, and shall continue it until a better one is adopted.

The boll-worm moths appear to be attracted to the same sweets as the cotton-moths, and are equally attracted to light. It follows, then, that the remarks made in the earlier part of this report will apply equally well here, and that the devices there recommended for the destruction of the cotton-moth may be here recommended for the destruction of the boll-worm moth.

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* Department of Agriculture Report, 1855, p. 235.

EXPLANATION TO PLATES TO REPORT ON COTTON INSECTS.

[When figures are enlarged, the natural sizes are indicated in hair-line at side, unless the enlargement is indicated in some other way.]

Explanation to Plate VII.

Aletia argillacea. (Original.)

Fig. 1.—Eggs on the lower surface of the leaf.
Fig. 2.—Very young larvae feeding.
Fig. 3.—Older larvae that have moved to the tender foliage at end of branch.
Figs. 4, 5, and 6.—Nearly full-grown larvae showing some of the color variations.
Fig. 7.—Margin of leaf as webbed about a pupa.
Fig. 8.—Pupa inclosed in fragment of leaf.
Fig. 9.—Pupa from which the leafy covering has been partly eaten by caterpillars.
Fig. 10.—Pupa entirely deprived of its case by larvae, but prevented from falling by the catching of its anal hooks in remnants of the cocoon.
Fig. 11.—Moth at rest, seen obliquely from above.
Fig. 12.—Moth seen from below, with wings expanded.
Fig. 13.—The same from above.
Fig. 14.—Nectar gland on midrib of cotton leaf.
Fig. 15.—Nectar gland at base of involucre.

Explanation to Plate VIII.

Heliothis armigera. (Original.)

Fig. 1.—Vertical section of a fully-expanded cotton flower, at end of the first day of blooming, showing a young boll-worm at work.
Fig. 2.—Boll-worm moth seen from below.
Fig. 3.—The same seen from above.
Fig. 4.—Dorsal view of a partly grown larva.
Fig. 5.—Side view of a nearly full grown larva.
Fig. 6.—Vertical section of a large green boll, one compartment of which contains a boll-worm that has eaten the contents of the cell, the bottom of which is occupied by its frass.
Fig. 7.—Full-grown green boll-worm.
Fig. 8.—Young rose-colored boll-worm, often seen in cotton flowers and on corn silk.
Fig. 9.—Pupa seen from below.
Fig. 10.—Young boll pierced by a small boll-worm. The injury has caused the involucre or "ruffle" to flare open.

Explanation to Plate IX.

Fig. 1.—Egg of *Aletia*, seen from above and from the side, enlarged. (Original.)
Fig. 2.—Anal armature of *Aletia* chrysalis, enlarged. (Original.)
Fig. 3.—Maxillae of adult *Aletia*, seen from the side, enlarged. (Original.)
Fig. 4.—Cross-section of maxillæ of *Aletia*, enlarged. (Original.)
Fig. 5.—*Attus nubilus*, dorsal view, enlarged. (Original.)
Fig. 6.—*Oxyopes viridans*, natural size. (Original.)
Fig. 7.—*Chrysopa perla*, eggs, larva, and adult. (After Packard.)
Fig. 8.—*Chrysopa oculata*, eggs and adult. (After Packard.)

Explanation to Plate X.

Fig. 1.—*Libellula trimaculata.* (After Packard.)
Fig. 2.—Eggs of *Mantis Carolina.* (After Riley.)
Fig. 3.—*Arma spinosa.* (After Glover.)
Fig. 4.—*Raphigaster hilaris.* (After Glover.)
Fig. 5.—*Prionotus cristatus*, eggs, larvae, and adults. (After Glover.)

Explanation to Plate XI.

Fig. 1.—*Acanthocephala femorata.* (After Glover.)
Fig. 2.—*Sinea multispinosa.* (After Glover.)
Fig. 3.—*Erax apicalis.* (Original).
Fig. 4.—*Tetracha Carolina.* (Original.)
Fig. 5.—*Tetracha Virginica.* (After Riley.)
Fig. 6.—Several forms of tiger beetles. (After Riley.)
Fig. 7.—*Calosoma callidum.* (After Riley.)
Fig. 8.—*Calosoma scrutator.* (After Riley.)

Explanation to Plate XII.

Fig. 1.—*Harpalus caliginosus.* (After Riley.)
Fig. 2.—Larva of *Harpalus.* (After Emerton.)
Fig. 3.—*Chauliognathus marginatus*, adult. (Original.)
Fig. 4.—*Chauliognathus Pennsylvanicus*, larva and adult. (After Riley.)
Fig. 5.—*Hippodamia maculata.* (After Packard.)
Fig. 6.—*Hippodamia convergens*, larva, pupa, and adult. (After Packard.)
Fig. 7.—*Coccinella munda.* (After Packard.)
Fig. 8.—*Coccinella 9-notata.* (After Packard.)
Fig. 9.—*Coccinella venusta.* (Original.)
Fig. 10.—*Epilachna borealis.* (After Packard.)
Fig. 11.—*Diabrotica 12-punctata.* (After Packard.)
Fig. 12.—*Polistes bellicosa.* (Original.)
Fig. 13.—*Chalcis ovata.* (Original.)
Fig. 14.—*Trichogramma minuta.* (After Riley.)

Explanation to Plate XIII.

Fig. 1.—*Cirrospilus esurus.* (Original.)
Fig. 2.—*Euplectrus*, sp. (Original.)
Fig. 3.—*Didyctium zigzag.* (Original.)
Fig. 4.—*Pimpla annulipes.* (After Riley.)
Fig. 5.—*Pimpla conquisitor.* (Original.)
Fig. 6.—*Sarcophaga carnaria.* (After Emerton.)

Expanation to Plate XIV.

Fig. 1.—*Sarcophaga carnaria*, var. *sarraceniae* (After Riley.)
Fig. 2.—*Anthomyia?* sp. (Original.)
Fig. 3.—*Phora aletiae.* (Original.)
Fig. 4.—Whitman's fountain pump.

Explanation to Plate XV.

Method of poisoning with the fountain pump.

Explanation to Plate XVI.

Fig. 1.—Young's sifter.
Fig. 2.—J. W. Johnson's machine, side elevation.
Fig. 3.—The same, plan.
Fig. 4.—N. A. Davis's sifter, rear elevation; 2, section of sifting attachment.
Fig. 5.—Egg of boll-worm, seen from above and from the side. (Original.)
Fig. 6.—Posterior end of boll-worm pupa, seen from below. (Original.)

Painted from Nature by Geo. Marx. A. Hoen & Co. Lithocaustic, Baltimore

THE COTTON WORM.

Aletia argillacea. (Huebner)

Painted from Nature by Geo. Marx.

A. Hoen & Co Lithocaustic, Baltimore

THE BOLL WORM.

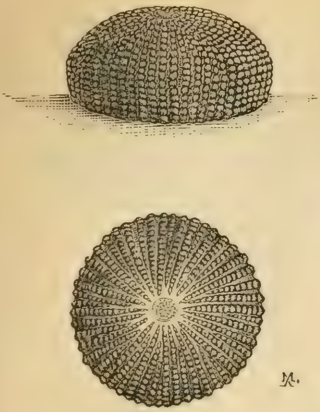
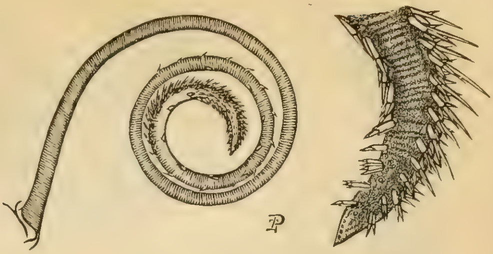


Fig. 1.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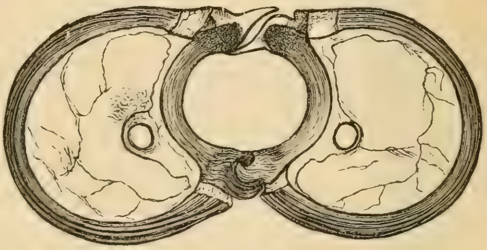
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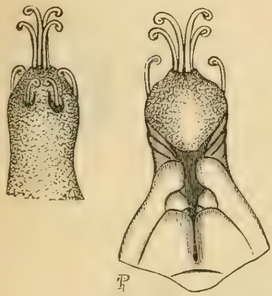


Fig. 2.


Fig. 6.

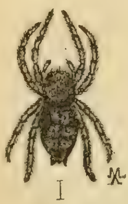
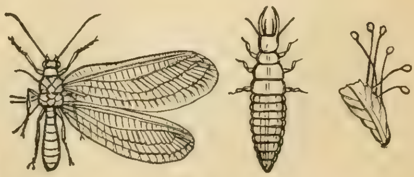


Fig. 5.


Fig. 8.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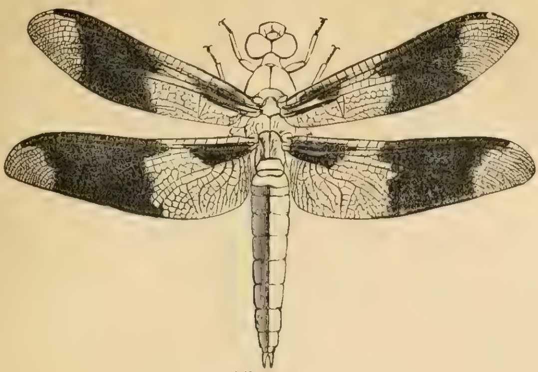

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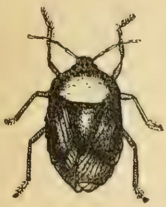

Fig. 4.

Fig. 3.

Fig. 2.

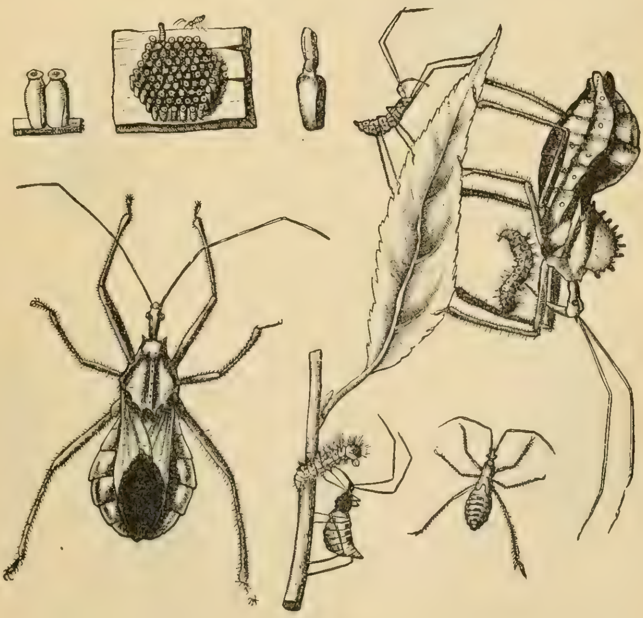

Fig. 5.

Fig. 1.

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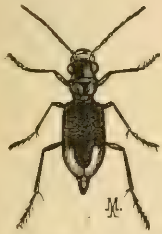

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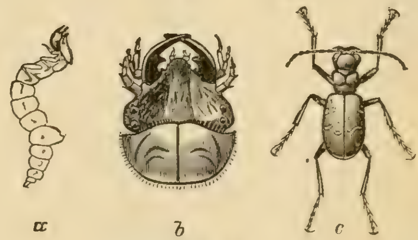

Fig. 6.

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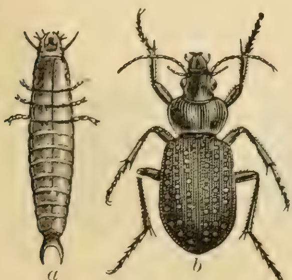

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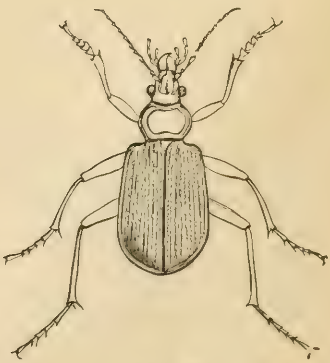

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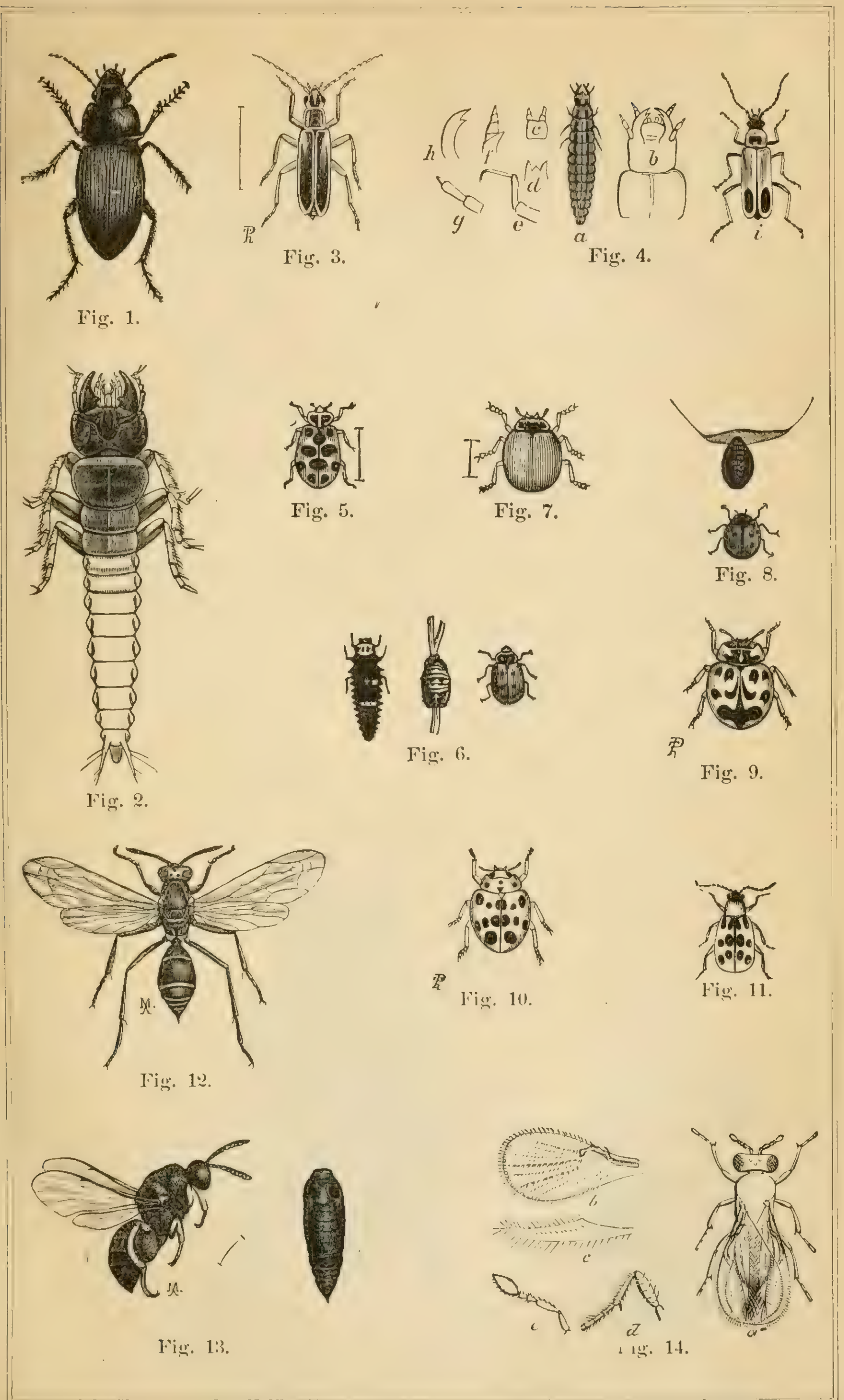
Fig. 1.
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Fig. 14.

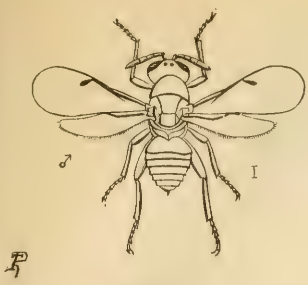
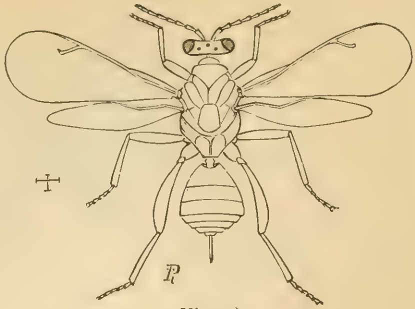


Fig. 1.



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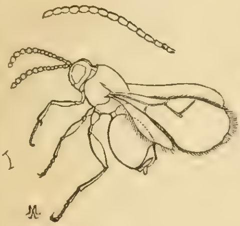

Fig. 3.

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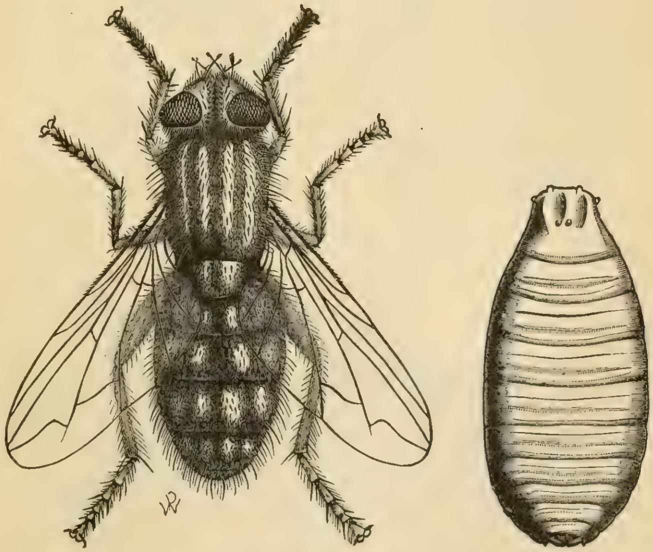

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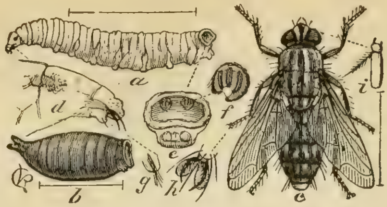

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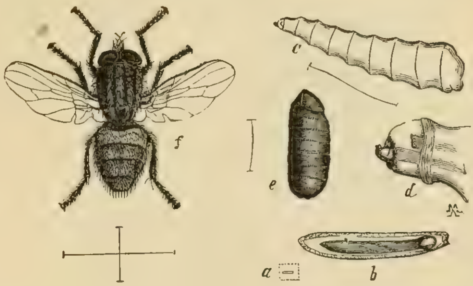

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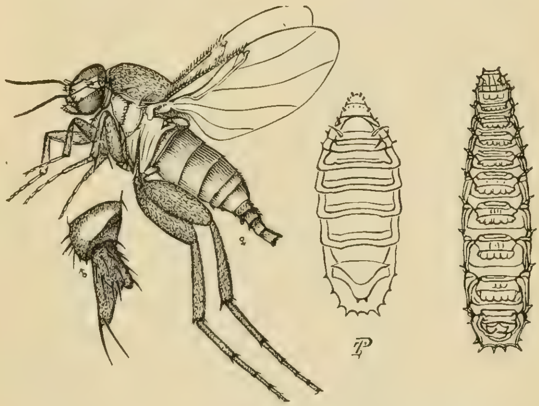

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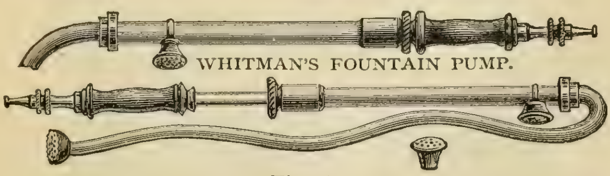

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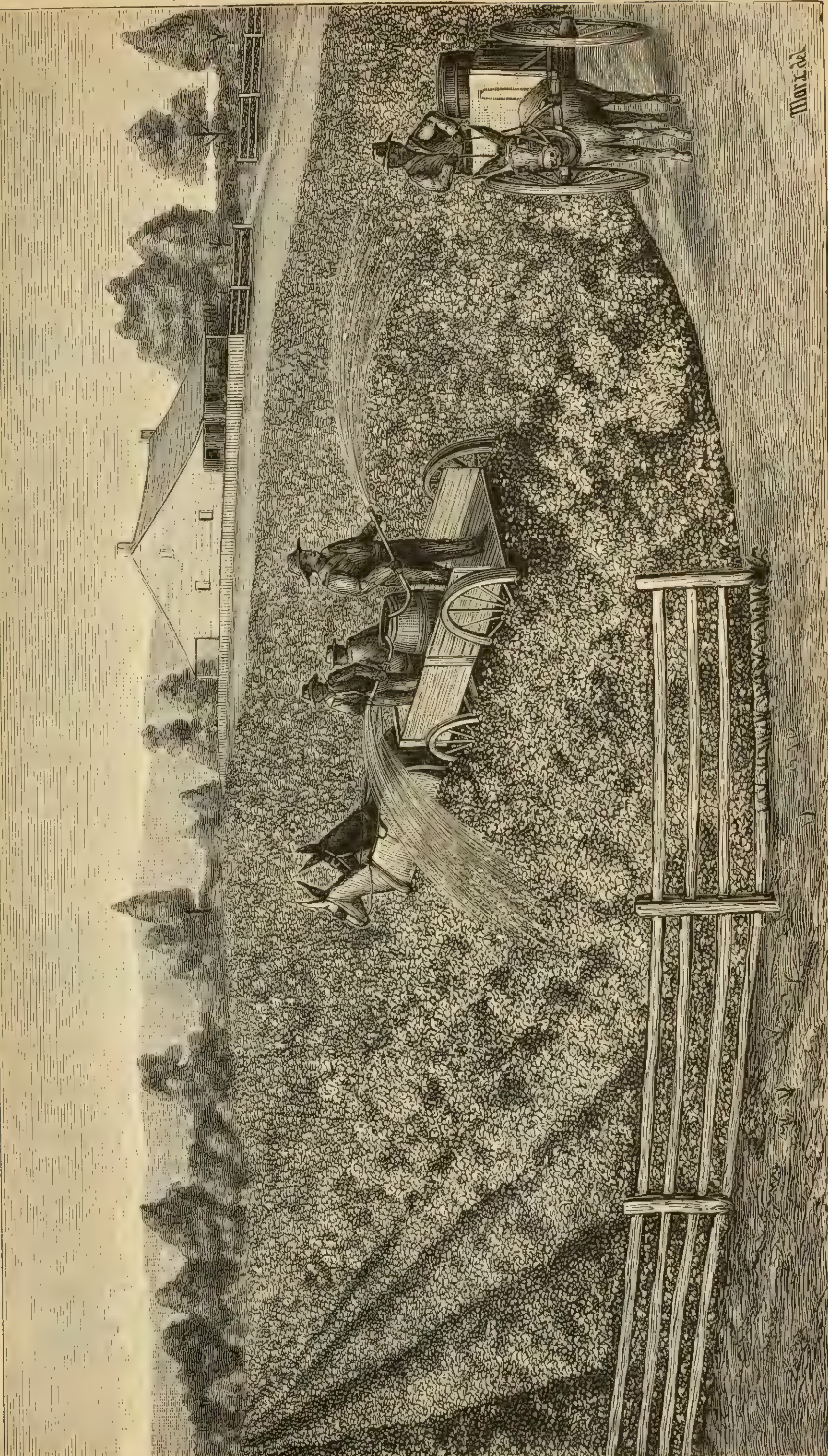
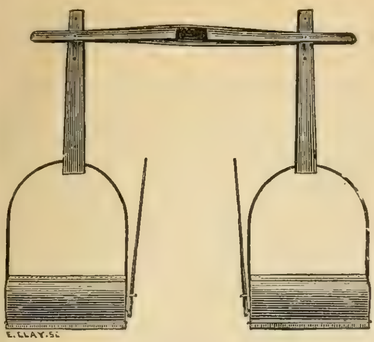


Fig. 51.—Method of poisoning with the fountain-pump.



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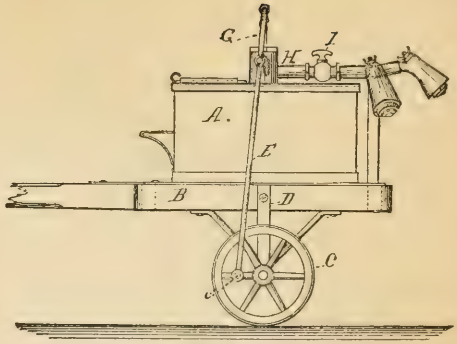

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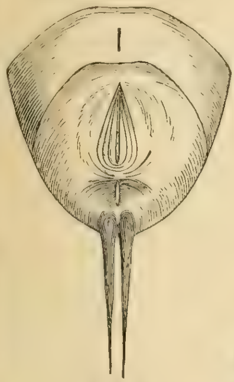

Fig. 6.

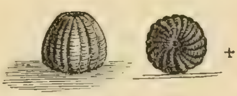

Fig. 5.

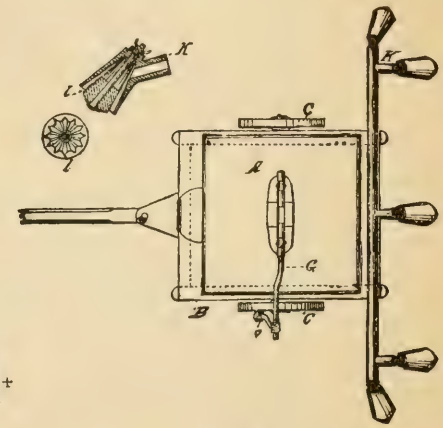

Fig. 3.

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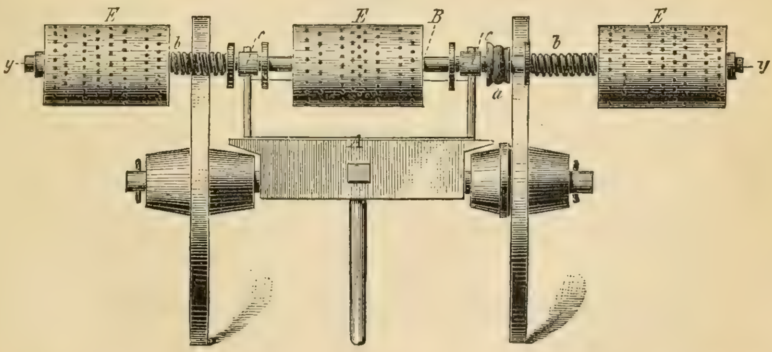

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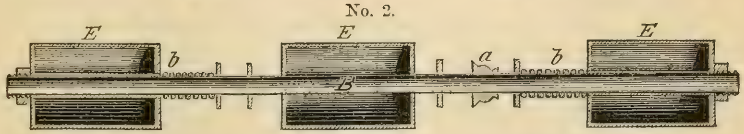


Fig. 4.

REPORT OF THE BOTANIST ON GRASSES.

SIR: We present herewith, in continuation of the work commenced last year, descriptions and figures of some twenty-five additional species of native or naturalized grasses, most of which are known to be more or less valuable for forage or hay. A few that are known to be of little or no agricultural value are introduced in order that they may be recognized, as it is sometimes important to know the appearance of weeds and pests, in order that they may be treated accordingly.

It is not to be supposed that all the grasses here described will be *generally* adapted to cultivation. Our country presents such a diversity of climate and soil that certain grasses, which have an established reputation and are of primary value in one section of the country, will not meet with the conditions favorable to their growth in another section; and there are some species which would be considered very inferior or worthless in one section, which are known to be of great value in others.

The descriptions and figures will enable persons interested to recognize our native grasses, and the chemical analysis will determine their composition and relative nutritive value.

The chemical analysis of the grasses described below will be found at page 105 of this report.

PANICUM ANCEPS—Flat-stemmed Panic-grass.

This is a perennial grass, growing rather sparsely in moist sandy or clay soil. It has a flattish, erect stem, growing 2 to 3 feet high, with smooth leaves, one foot or more long, of a bluish-green color, and mostly near the base of the stem. The panicle is usually a foot long, with short branches near the top, the lower ones 3 to 6 inches long, more distant, and nearly erect, or somewhat spreading. Sometimes there are several lateral panicles from the upper joints of the culm. The rhizoma is thick, scaly, and creeping near the surface of the ground.

The spikelets are lanceolate, a little curved and sessile, or with short pedicels. Each spikelet consists of one perfect and one neutral flower, and two glumes, the lower of which is only half as long as the strongly 5 to 7 nerved upper one. The lower palet of the sterile flower is as long as the upper glume and much like it in texture, while its inner palet is thin, obtuse, and nearly half shorter. The perfect flower, as in most species of *Panicum*, is thick and hard in texture, one-third shorter than the upper glume, oblong, and consisting of two smooth palets, the outer one inclosing the inner, which again incloses the flowering organs.

This cannot be considered a valuable grass, but it frequently occurs in neglected and poor land in sufficient quantity to afford considerable grazing for stock. It makes its growth late in the season, usually reaching the flowering stage in August.

Mr. Mohr, of Mobile, remarks that it is not much relished by stock, being rather harsh and dry. (See Plate I.)

PANICUM AGROSTOIDES.

This is very much like the preceding species, but of a much larger and more vigorous growth, developing flower panicles from several of the joints as well as at the apex. These panicles are more densely flowered than those of *P. anceps*. The spikelets are somewhat smaller

and narrower, and the lower glume is longer and more pointed. The perfect flower is said to be bearded at the apex, but this will be observed only with the aid of a good magnifier, and I find *P. Anceps* not to differ in this respect. The panicle usually has a reddish color, and somewhat resembles that of Red-top (*Agrostis vulgaris*), hence the specific name.

This grass grows commonly in large clumps in wet meadows, or on the muddy margins of rivers and lakes. It grows from four to six feet high, and produces a large amount of foliage which makes fair hay if cut before flowering time; if left later it contains too many wiry stalks. (See Plate II.)

PANICUM PROLIFERUM—Crab-grass, Sprouting Crab-grass.

This is an annual species growing usually in low, moist ground, and also in cultivated fields, especially in corn-fields, appearing and accomplishing most of its growth late in the season. The stems are seldom erect except in small or young specimens; in thrifty plants the stems become decumbent, spreading widely and rooting at many of the lower joints. The stems are usually only two or three feet long, but we have specimens from Mr. S. Corley, of Lexington, S. C., that are seven feet long. The culms are thick and juicy, and generally flattened and bent at the joints, especially below. The leaves are 3 inches to 2 feet long, and half an inch or more wide.

The whole plant is smooth, except some roughness about the branches of the panicle. The lower joints give out numerous branches which develop flowering panicles that are partly inclosed in the large leaf sheaths. These panicles vary in size from a few inches to 2 feet in length. Large specimens have a very diffuse and handsome appearance. The spikelets are pale green, rarely purplish, about 1 line long, and formed of the perfect flower, a neutral flower, which sometimes has one and sometimes two palets, and the two glumes. The neutral flower is a little longer than the perfect one; the lower glume broad and short, the upper acute and strongly 7-nerved.

This grass has a very wide range, being found in the Northern and Western as well as in the Southern States, growing abundantly in low waste grounds, as also, late in the season, in cultivated grounds.

Mr. Charles Mohr, of Mobile, says of it:

In damp, grassy places it prefers rich ground, throughout the coast region. It commences to vegetate vigorously in the hottest part of the summer months, throwing out numerous shoots from the joints, forming large branched bushes. The foliage is rich and tender, and the succulent, rather thick, stems are sweet and juicy. After cutting, it throws out numerous sprouts from the lower joints, which grow rapidly so as to allow repeated cuttings until frost. It is, through all stages of its growth, much relished by horses and cattle. (See Plate III.)

PANICUM CAPILLARE—Witch grass.

This is an annual grass, varying in height from 6 inches to 2 feet. It has a large terminal panicle which, when mature, is very diffuse, with long capillary branches. The leaves and sheaths are usually covered with long spreading hairs. It is very common in cultivated grounds, making its growth late in the summer, and after maturity the tops frequently break off and are blown about, and often accumulate in quantities in fence corners. It is mostly rejected by cattle, especially the very hairy forms. There is a smoothish form growing in Texas and the

Western Territories, which will probably be more valuable. We give a figure of it chiefly for comparison, so that it may not be mistaken for a more valuable species. (See Plate IV.)

PANICUM GIBBUM.

This is a perennial species, growing in swamps and low wet ground in the Southern States from North Carolina to Florida. The stem is decumbent, branching and rooting at the lower joints. The panicle is 3 to 5 inches long, and narrow from the erect, appressed branches. The spikelets are oblong or lance-oblong, rather obtuse, although narrowed above. The upper glume is strongly 11-nerved, swollen at the base, and twice as long as the smooth fertile flower. The lower glume is small, about one-fourth the length of the upper one. The leaves are smooth, or rarely somewhat hairy, one-half inch broad and 6 to 8 inches long. The whole plant is of a deep-green color. The flowers drop off soon after flowering.

This grass, if occurring in abundance, would be of considerable value, as it furnishes a good deal of nutritious matter. (See Plate V.)

PANICUM DIVARICATUM—Cane-like Panic grass.

This is a tropical and subtropical species, found in our country only in Florida and the Gulf States, near the coast. It is a shrubby plant, the culms being woody and persistent, like a small kind of cane. Of course only the young shoots and leaves can be eaten by cattle. In the districts where it grows it may be utilized, as an analysis of its composition gives a very good result. The larger stems are of the size of a goose-quill. It is smooth and decumbent, with short spreading branches.

The leaves are lanceolate, 2 to 3 inches long by 4 to 5 lines wide, gradually pointed. The panicles terminate the branches, are 2 to 4 inches long, with comparatively short divergent branches and few flowers. The spikelets are obovate and swollen, about 2 lines long and smooth, except a very minute cottony tuft at the apex. (See Plate VI.)

ANDROPOGON MACROURUS—Heavy-topped Broom grass.

We present a figure of another of the species of *Andropogon*, Broom grass or Broom sedge, the *Andropogon macrourus*. It is very frequent on low sandy ground, near the coast, from New Jersey to Florida, and thence westward to Texas. It has a stout culm 2 to 3 or even 4 and 5 feet high, "bushy branched at the summit, loaded with very numerous spikes forming thick leafy clusters." The fertile flower has a capillary awn 3 or 4 times the length of the glume, and the sterile flower, which is usually present in the genus, is in this species reduced to a slender plumose pedicel.

None of the species of Broom grass are to be recommended for cultivation. The analyses show their relative value, and how much may be expected from their utilization on lands where they occur. (See Plate VII.)

TRITICUM REPENS—Couch grass, Quack grass.

There has been a good deal of discussion relative to this grass, some pronouncing it one of the vilest of weeds, and others claiming for it high

nutritive qualities overweighing all the disadvantages of its growth. Whichever party may be right, it is proper that farmers should be acquainted with it in order to know how to treat it, and hence our figure and description. It forms a dense sod by means of its far-reaching creeping rhizomas or rootstalks, which have short joints, and root tenaciously at every joint.

It has an abundance of foliage, and sends up a flowering culm, 2 to 3 feet high, which is terminated by a close, narrow spike of flowers from 3 to 6 inches long. This spike consists of a succession of closely set spikelets, one at each joint of the rachis, and placed flatwise with the side against the stalk. Each spikelet contains several (3 to 8) flowers, with a pair of nearly equal and opposite, 5 to 7 nerved glumes at the base. These glumes are usually acutely pointed and sometimes short awned. The lower palet of each flower is convex on the back and pointed or awned at the tip; the upper palet flattened and bristly fringed on the margins. There are many forms or varieties of this grass. In the Eastern States it is supposed to be introduced, but on the arid plains of the West it is undoubtedly indigenous, and in many places there it is the most common grass. In the typical form the leaves are flat, but in the Western varieties the leaves are frequently involute or rolled together in a cylindrical form.

Hon. J. S. Gould, in writing of this grass, says:

> The farmers of the United States unite in one continuous howl of execration against this grass, and it seems strange, when every man's hand is against it, that it is not exterminated. Yet we could never really satisfy ourselves that its presence in meadows and pastures was such an unmitigated curse. In lands where alternate husbandry is practiced, it must be admitted to be an evil of great magnitude. Its hardiness is such, and its rapidity of growth is so great, that it springs up much more rapidly than any other crop that can be planted and chokes it. Still it has many virtues. It is perfectly cosmopolitan in its habits. It is found in all sorts of soils and climates. Its creeping roots are succulent, sweet, and very nutritive, and are greedily devoured by horses and cows.

Having the testimony, *pro* and *con.*, every farmer must decide for himself as to the cultivation of this grass. Its very persistence and hardiness is greatly in its favor in cases where land is wanted for a permanent pasture.

Mr. Richard Gaines, of Colorado Springs, Colo., sent specimens of the Western form of the species, and says:

> We think this is the best grass grown, superior to timothy or clover. We call it blue stem or blue joint; no richer hay can be made from anything known.

(See plate VIII.)

BROMUS SECALINUS—Chess or Cheat.

We introduce this grass, not to recommend its cultivation, but to familiarize those interested with its appearance and characters. Many farmers know it well, as it occurs in their wheat fields. It is an old tradition, which some farmers still cling to, that chess is a degenerated wheat, that the action of frost and other causes occasion the deterioration, whereas the truth undoubtedly is that chess-seed was either in the land or in the seed sown, and being more hardy than wheat it survived the frost and took possession of the ground. Some years ago this grass had a temporary popularity under the name of Willard's Brome grass, but it was soon abandoned when brought into competition with better grasses.

It has a stout upright culm, 2 to 3 feet high, the panicle being from 4 to 6 inches long, rather spreading, and the large spikelets somewhat

drooping when ripe. Usually there are 3 to 5 branches at each joint of the panicle; these branches are of different lengths, from ½ inch to 2 inches, and each with 1 to 3 large spikelets. The spikelets are usually from 5 to 10 flowered; the glumes unequal, nerved, shorter than the flowers; the lower palet is convex or compressed, keeled on the back, with an awn variable in length from below the point. In the South it would perhaps be a good winter grass, like its relative *Bromus unioloides*, but it is not as vigorous a grass as that species and does not produce such an abundance of foliage. (See Plate IX.)

ELYMUS CANADENSIS—Large Wild rye, Lyme grass.

A perennial coarse grass, growing on river banks and in rich shaded woods. Culms 2 to 4 feet high, leafy, terminated by a cylindrical loose spike 4 to 8 inches long, with the spikelets placed at intervals of about half an inch on the rachis. The spikelets are mostly in pairs at each joint, each composed of from 3 to 5 flowers. The glumes are narrow, strongly nerved, and tapering to an awn which is rather shorter than the awn of the flowers proper. The lower palet of each flower is thick in texture, narrow, and extending into a long, somewhat curved awn or beard, the palet with the awn being an inch or more in length. The upper palet is thinner in texture, obtuse, and not awned, fringed with short hairs on the margin. The spike is usually drooping at the top, and rather graceful in appearance. The leaves are broad and rough, the lower ones 9 to 12 inches long.

In some localities this is common in low meadows, and is cut with other native grasses for hay. If left until maturity it becomes too coarse to be of much value. In some portions of the Southern States this grass is known as Terrell grass, from having been prominently brought to notice by Dr. Terrell, of Sparta, Ga. Mr. C. W. Howard writes concerning it as follows:

> This grass will live on thin land, but the soil, to make it valuable, must be rich—the richer the better. It lasts for years. I have known it to occupy and flourish on the same spot for twenty years. Horses, sheep, and cattle are very fond of it during the winter and spring; hogs reject it. Orchard, blue, or meadow-oat grass are either of them preferable to it where they thrive. Whatever doubt there may be of their thriving in a given locality, there can be no doubt of the thrift of the Terrell grass in any part of the South, however hot it may be, if the soil be made rich. The planter living in the flat and somewhat sandy portions of the South who says he cannot get a good winter pasture has certainly never tried the Terrell grass on rich land.

(See Plate X.)

FESTUCA PRATENSIS—Meadow Fescue grass.

This, although not a native species, has been introduced with foreign seeds, and is now frequently met with in good meadows, particularly in the Eastern States. It is a perennial grass, varying from 2 to 4 feet in height. The leaves are flat and rather broad, and about 1 foot long. The panicle is generally branched, erect and narrow, from 6 inches to nearly 1 foot long. The spikelets are lanceolate, about half an inch long, and consisting of from 5 to 10 flowers. The glumes are unequal, the inner one largest, and somewhat 3 nerved; the outer one shorter, and nerveless. The outer palets are firm in texture, scarious at the edge, 5 nerved, acute, and sometimes with a short, but distinct, awn at the apex.

This is one of the standard meadow grasses in Europe. Cattle are said to be very fond of it, both green and as hay. It is deserving of more extensive cultivation in moist meadows. By some botanists this

is considered a variety of the tall Fescue grass (*Festuca elatior*), which is taller, stouter, and more reed-like. (See Plate XI.)

GLYCERIA AQUATICA—Reed Meadow grass.

This grass has a stout, erect, leafy culm, 3 to 4 feet high. The leaves are a foot or two long, one-quarter to half an inch wide, flat, and usually somewhat rough, especially on the edges.

The panicle is much branched, large, 9 to 15 inches long, the branches arranged in half whorls alternately on the rachis, at first erect, but spreading with age. The spikelets are oblong, about a quarter of an inch long, 5 to 9 flowered, with capillary pedicels. The lower third of the branches is naked. The glumes are unequal, 1 nerved, and somewhat obtuse. The lower palet is obtuse, strongly 7 nerved, and entire at the apex. The upper palet is somewhat 2 toothed, and about as long as the lower.

Hon. J. S. Gould says:

> This grass is made into hay, which is liked by cattle. It flowers in July; it is found in most parts of Europe, and is widely diffused in this country in wettish meadows.

It may be doubted whether the European grass of this name is identical with the American one, although certainly very similar. (See Plate XII.)

GLYCERIA NERVATA—Nerved Meadow grass.

This is similar in appearance and habit to the preceding, but smaller. The culms are 2 to 3 feet high, usually somewhat decumbent below, often branching and rooting at the lower joints. It varies greatly in size and in the magnitude of the panicle. It usually grows along the wet margins of streams in close patches. The panicle is from 4 to 8 inches long, nodding when young, loose and spreading with capillary branches. The leaves are 8 to 12 inches long, and 2 to 3 lines wide. The spikelets are small, about 5 flowered, oblong, becoming purplish with age. The upper glume is 3 nerved and obtuse, the lower rather acute and scarious on the margin. The lower palets are truncate-obtuse, and prominently 7 nerved; the upper one 2 toothed at the apex. It is a very common grass in moist grounds and swamps, extending to the Rocky Mountains and northward to Alaska. (See Plate XIII.)

POA COMPRESSA—Wire grass, Blue grass.

This species has sometimes been confounded with the Kentucky Blue grass (*Poa pratensis*), from which it differs in many particulars. It is found in many old pastures, on dry banks, and in open woods.

The culms are hard and much flattened, 1 foot to 18 inches long, more or less decumbent and bent at several of the lower joints. The leaves are scanty, smooth, short, and of a dark, bluish green color. The panicle is short and contracted, 1 to 3 inches long. The branches are in pairs or threes, short and rough, and frequently one-sided. The spikelets are ovate oblong, flat, short-pedicelled, and generally 5 to 6 flowered. The glumes are acute, 3 nerved, often tinged with purple.

The lower palets are 3 to 5 nerved, the lower part of the nerves finely hairy. At the base of the florets a delicate web of hairs is usually present.

This species may be distinguished from *Poa pratensis* by its flattened

decumbent stems, shorter leaves, shorter and narrower panicle, with fewer branches. It forms a looser turf, but has a firm hold by means of its creeping rhizoma.

Very contradictory accounts have been given as to its agricultural value, some denouncing it as worthless and others speaking well of it. Hon. J. S. Gould says, respecting it:

> It is certain that cows that feed upon it both in pasture and in hay give more milk and keep in better condition than when fed on any other grass. Horses fed on this hay will do as well as when fed on timothy hay and oats combined.

(See Plate XIV.)

AVENA STRIATA—Wild Oat grass.

This grass grows on rocky hills in New England and New York. The culms are about 2 feet high, smooth and slender. The leaves are narrow, and 4 to 6 inches long; the panicle is slender and drooping; the upper 2 or 3 branches single, undivided, and short-pediceled; the lower branches in twos or threes, with longer pedicels. The upper branches have each only a single spikelet, which is $\frac{1}{2}$ to $\frac{3}{4}$ inch long, and 3 to 6 flowered. The glumes are much shorter than the flowers, thin, scarious margined, purplish, and acute. Each of the flowers has a short tuft of hairs at the base. The lower palet is 7 nerved, 4 lines long, with a sharply 2-toothed apex, just below which rises a slender bent awn. The upper palet is acute, shorter than the lower, with two marginal fringed nerves.

This grass belongs to the same genus as the cultivated oats, which is *Avena sativa*. Its range is to the northward, being addicted to a cool elevated country. Its productiveness and value for agricultural purposes has not been tested. (See Plate XV.)

DANTHONIA SPICATA—Spiked Wild Oat grass.

This grass grows in small clumps on barren hills or in poor clay lands. The leaves are mostly in a tuft near the ground, short, narrow, and curled in dry weather. The culms are $1\frac{1}{2}$ to 2 feet high, erect and slender. The panicle is only an inch or two long, mostly simple, and of 4 to 7 spikelets, with very short pedicels. It is a very poor grass. Hon. J. S. Gould says:

> As it will grow on hard clay lands where nothing else will, it might be worth while to sow its seed on such lands, as it is certainly better than nothing, but the better plan is to manure the soil so that it will produce the richer grasses.

(See Plate XVI.)

DANTHONIA COMPRESSA—Compressed Oat grass.

This species was discovered and described in 1868 by Mr. C. F. Austin. It grows in Pennsylvania, New York, and New England. Mr. C. G. Pringle sends it from Vermont, growing on dry hillocks along the Waterbury River. It also grows on the summit of the Roan Mountain, North Carolina, over large areas, and furnishes good summer pasturage. Probably it occurs on the other mountains of the Alleghany Range. It differs from the preceding species in forming a compact sod, by having more numerous and larger leaves, by a longer and more spreading panicle, and by the two long, slender teeth on each side of the awn of the flowers. (See Plate XVII.)

PHALARIS INTERMEDIA—American Canary grass.

This species resembles the Canary grass (*Phalaris canariensis*), which produces the seed commonly sold as food for Canary birds. It is, however, a taller and more robust species, growing 2 to 3 feet high, with a stout, erect culm, and broadly linear leaves, which are from 4 to 10 inches long. The spike is oblong and compact, 1 or 2 inches long, or in the variety *angustata* it is narrow and cylindrical, 3 or 4 inches long, and more or less interrupted at the lower part. The spikelets are 3 flowered, the 2 lower flowers being imperfect and reduced to 2 hairy scales. The upper flower is perfect, consisting of 2 boat-shaped palets which become thick and hard, and 2 nearly equal, narrowly-keeled glumes which are one-third longer than the ovate hairy flower.

This species grows in South Carolina and the Gulf States, extending to Texas, and then stretching across to the Pacific coast and occurring through California and Oregon. It has frequently been sent us from the Southern States as a valuable winter grass.

Mr. Thomas W. Beaty, of Conwayborough, S. C., sent specimens for analysis, and says:

> The grass I send you was planted last September, and the specimens were cut on the 9th instant (March). You will notice that it is heading out, and is just now in a right condition for mowing. It is wholly a winter grass, dying down in the latter part of April and first of May, and it seems to me should be a great thing for the South if properly introduced and cultivated, or rather the ground properly prepared and the seed sown at the right time. It would afford the best of green pasturage for sheep and cattle all winter. It is what we call Gilbert's Relief grass.

Many years ago Dr. Lincecum, of Texas, experimented with this grass, and recommended it highly. (See the Patent Office Report for 1860.)

In California the grass is called California timothy, and is said to have no agricultural value. It is an annual or biennial. (See Plate XVIII.)

ANTHOXAUTHUM ODORATUM—Sweet Vernal grass.

A perennial grass, much employed as a part of mixed lawn grasses, and also in meadows. It grows thinly on the ground, with slender culms, seldom more than 1 foot to 18 inches in height, and scanty in foliage. The panicle is close and narrow, except that it expands considerably during flowering time. The spikelets consist of two thin keeled glumes, of which the lower is only about half the length of the upper, and the upper closely incloses the flowers, of which there are two or three in each spikelet; only the central or upper one is perfect, and the two lower ones reduced to an awned hairy palet on each side of the perfect flower.

The perfect flower consists of two small unawned palets, two stamens, and two styles. The awn of one of the imperfect flowers is long and twisted, that of the other is shorter and straight. It is very fragrant, and gives a pleasant odor to hay which contains it.

Mr. J. Stanton Gould says:

> It is nowhere considered a very valuable variety for hay, as the culms are wide apart, very thin, and bear but few leaves; hence it gives a light crop of hay.

(See Plate XIX.)

DACTYLIS GLOMERATA.—Orchard grass.

This is one of the most popular meadow grasses of Europe, and is well known to most farmers in the Northern and Eastern States.

It is a perennial grass, of strong, rank growth, about 3 feet high, the culm and leaves roughish, the leaves broadly linear, light green, and 5 or 6 on a culm.

The panicle is generally but 2 or 3 inches long, the upper part dense from the shortness of the branches, the lower branches longer and spreading, but with the spikelets glomerated or tufted closely together. The spikelets are usually 3 to 4 flowered, one sided, on short rough pedicels. The glumes are pointed and somewhat unequal, the upper one being smaller and thinner than the lower. The lower palet in each flower is ovate-lanceolate, roughish, and ending in a sharp point or short awn, and is rather longer than the glumes.

Mr. J. S. Gould says, respecting this grass:

> The testimony that has been collected from all parts of the world for two centuries past establishes the place of this species among the very best of our forage grasses, and we have not the shadow of a doubt that the interests of our graziers and dairymen would be greatly promoted by its more extended cultivation. It is always found in the rich old pastures of England, where an acre of land can be relied upon to *fatten* a bullock and four sheep. It is admirably adapted for growing in the shade, no grass being equal to it in this respect except rough-stalked meadow grass (*Poa trivialis.*)

(See Plate XX.)

BOUTELOUA OLIGOSTACHYA—Grama grass.

The name Grama grass is given to several species of *Bouteloua* growing on the great plains of the eastern slope of the Rocky Mountains and the high table-lands of Texas. They are valuable grasses for grazing purposes, but they grow too short and too thinly to be advantageous for hay. They grow in bunches with a mass of short leaves at the base. The principal characters of the *B. oligostachya* are as follows:

The culms or stalks are from 1 to 1½ feet high. Near the top there are usually two or three, sometimes more, curved flower spikes, about 1½ inches long, consisting of numerous sessile flowers closely set on one side of the stalk or rachis. The spikelets consist of the pair of glumes, one perfect flower, and one or two neutral or rudimentary ones. The palets of the perfect flower are two or three toothed or awned at the apex.

Although this is one of the most valuable of grasses for the western plains, it has never been successfully cultivated in the moister districts of the sea-coast. (See Plate XXI.)

SPARTINA CYNOSUROIDES—Fresh-water Cord grass.

This species much resembles the salt reed or marsh grass of the Atlantic coast, which is much valued for making marsh hay. The fresh-water Cord grass grows away from the sea-coast, and in the Western States becomes very plentiful, forming a large part of the product of the sloughs or wet marshes of that region. It is a perennial, tall, coarse, and stout grass, growing from 3 to 5 feet high, with leaves 2 or 3 feet long. It is frequently cut for hay, but is a very coarse inferior article unless cut when very young. It gives good feed very early in the spring, but becomes so coarse as soon to be rejected by the cattle when anything better is procurable. In the bottom lands of the Mississippi it is abundant, and has to some extent been manufactured into paper. The top of the culm for about one foot is occupied by from 5 to 10 or more flower spikes, which are from 1½ to 3 inches long, and consist each of two rows of closely set spikelets on one side of the rachis. The spikelets are each

1-flowered, flattened laterally; the glumes linear-lanceolate and awl-pointed, the upper one very rough on the keel, and twice the length of the lower. The two palets are nearly equal, and about the length of the lower glume. (See Plate XXII.)

MUHLENBERGIA GLOMERATA.

This grass grows in wet swampy grounds, chiefly in the northern and western portions of the United States. It is found in Colorado, Utah, and Nevada, and some varieties of it in Texas and New Mexico.

The typical form is 2 to 3 feet high, stiffly erect and unbranched, generally purplish below the joints. The culm is hard, somewhat compressed, and very leafy. The panicle is narrow, 2 to 4 inches long, composed of numerous close clusters of flowers, becoming looser, and sometimes interrupted below, forming an interrupted glomerate spike. The spikelets are 1-flowered and closely sessile in the glomerules or clusters. The glumes are linear-lanceolate, gradually tapering into an awn or bristle of equal length. The flower is one-third to one-half shorter than the glumes, hairy at the base and lower part. The palets are unequal and very acute. The root-stalk or rhizoma is hard and knotty, and furnished with numerous short, firm shoots or stolons.

In the Eastern States it is utilized as one of the native products of wet meadows in the making of what is called wild hay. Specimens have been sent from Colorado and Kansas, and recommended as an excellent grass for hay. (See Plate XXIII.)

CINNA ARUNDINACEA—Wood Reed grass.

A perennial grass with erect, simple culms from 3 to 6 feet high, and a creeping rhizoma, growing in swamps and moist shaded woods.

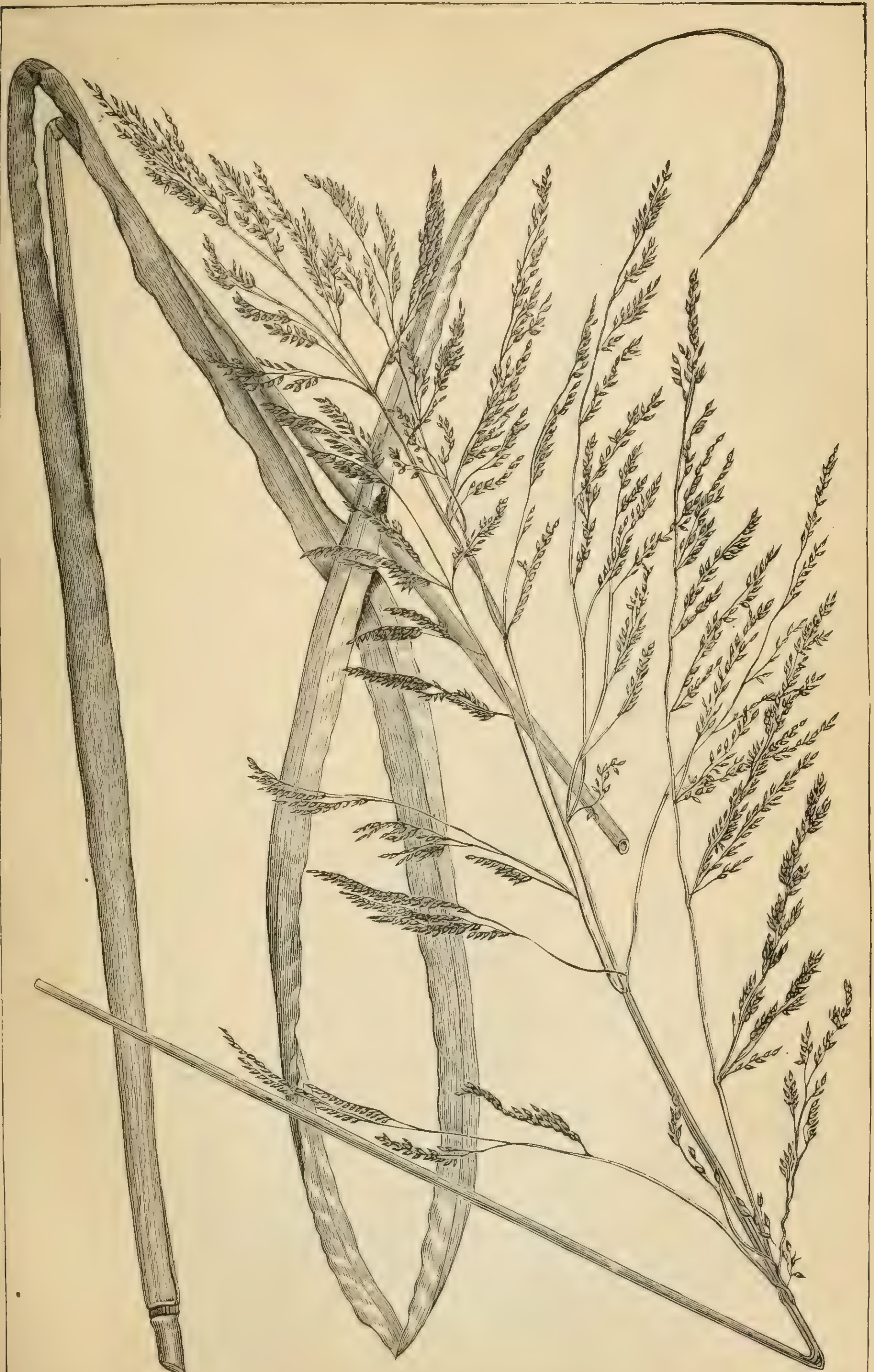
The panicle is from 6 to 12 inches long, rather loose and open in flower, afterwards more close. The branches in fours and fives, spreading in flower; after, more erect. The spikelets are 1-flowered, much flattened, crowded in the panicle, and somewhat purplish in color. The glumes are lanceolate, acute, and strongly keeled, the lower rather shorter, the upper a little longer than the palets. The flower is visibly stalked in the glumes, smooth and naked; the palets much like the glumes, the lower one longer than the upper, and sometimes having a short awn on the back, or sometimes naked. The leaves are broadly linear-lanceolate, about 1 foot long, 4 to 6 lines wide, and with a conspicuous elongated ligule.

This leafy stemmed grass furnishes a large quantity of fodder, but experiments are wanting to determine its availability under cultivation. (See Plate XXIV.)

TRICUSPIS PURPUREA—Sand grass.

This is an annual grass, growing in tufts in sandy ground along the Atlantic coast, and also on the sandy shores of some of the lakes and rivers of the interior. The culms are about 1 foot in height, rather decumbent at the base, with numerous (8 to 10) short joints, and a corresponding number of narrow awl-shaped leaves 2 to 3 inches long, which are bearded with hairs at the top of the sheaths. There are usually several lateral panicles of flowers, as well as a terminal one. The lateral ones are inclosed within the sheaths; the terminal one usually exserted, but short and simple. The spikelets are 2 to 5 flowered, the glumes

PANICUM ANCEPS.



PANICUM AGROSTOIDES.

PANICUM PROLIFERUM.

PANICUM CAPILLARE.

PANICUM GIBBUM.

PANICUM DIVARICATUM.

ANDROPOGON MACROURUS.

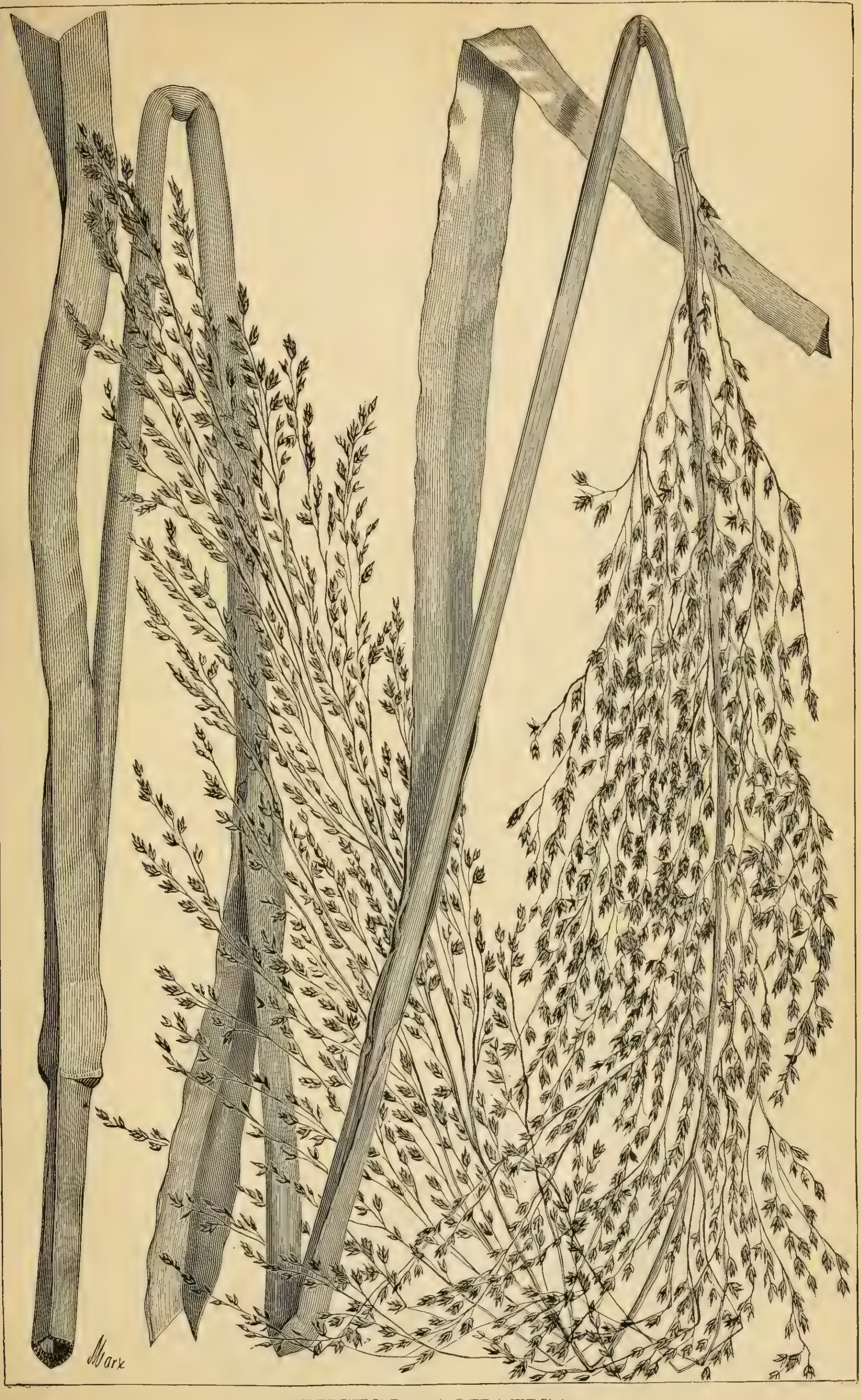
TRITCUM REPENS.

BROMUS SECALINUS.

ELYMUS CANADENSIS.

FESTUCA PRATENSIS.

FESTUCA OVINA.



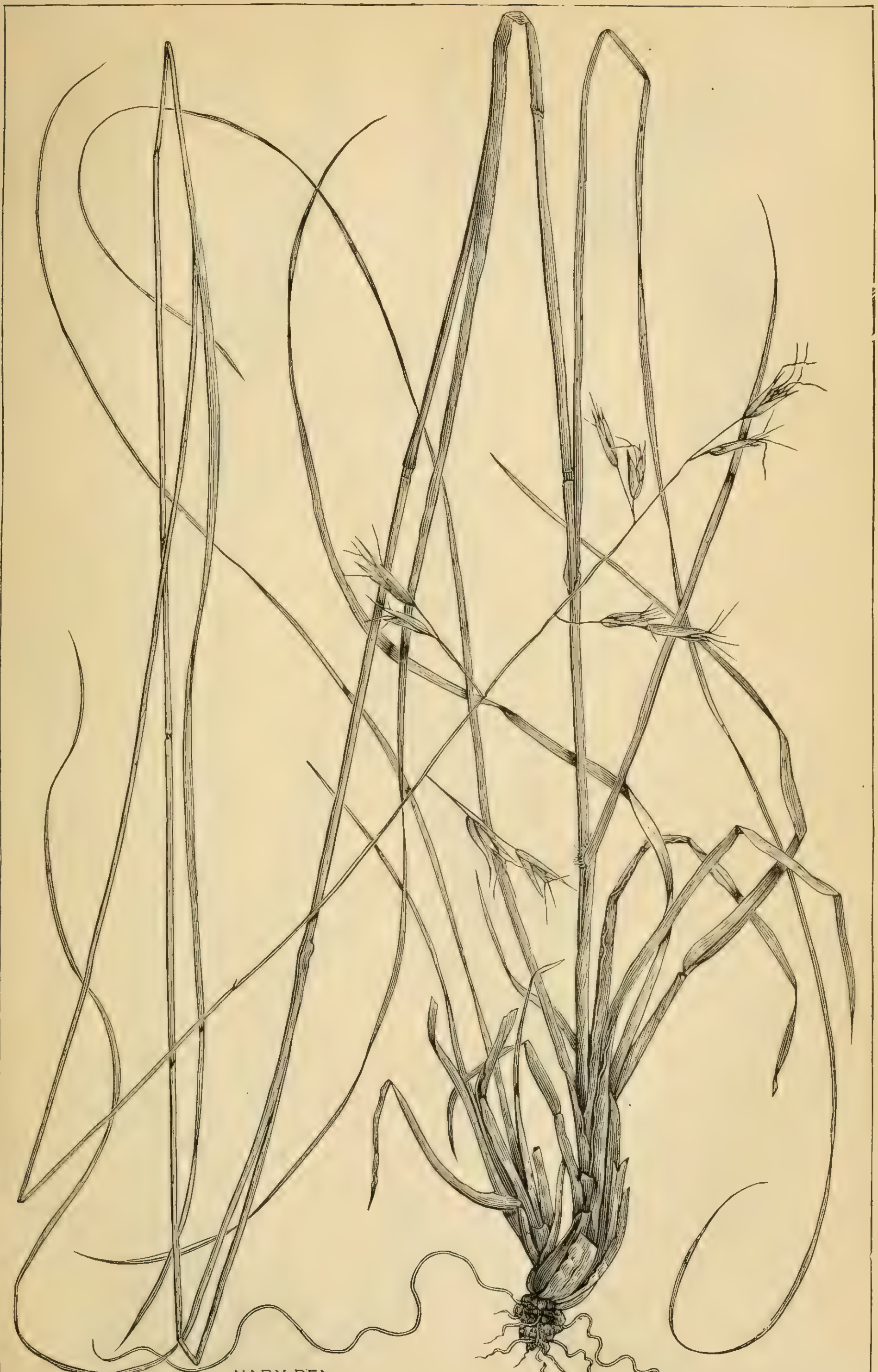
GLYCERIA AQUATICA,

GLYCERIA NERVATA.

POA COMPRESSA.

AVENA STRIATA.

DANTHONIA SPICATA.



DANTHONIA COMPRESSA.

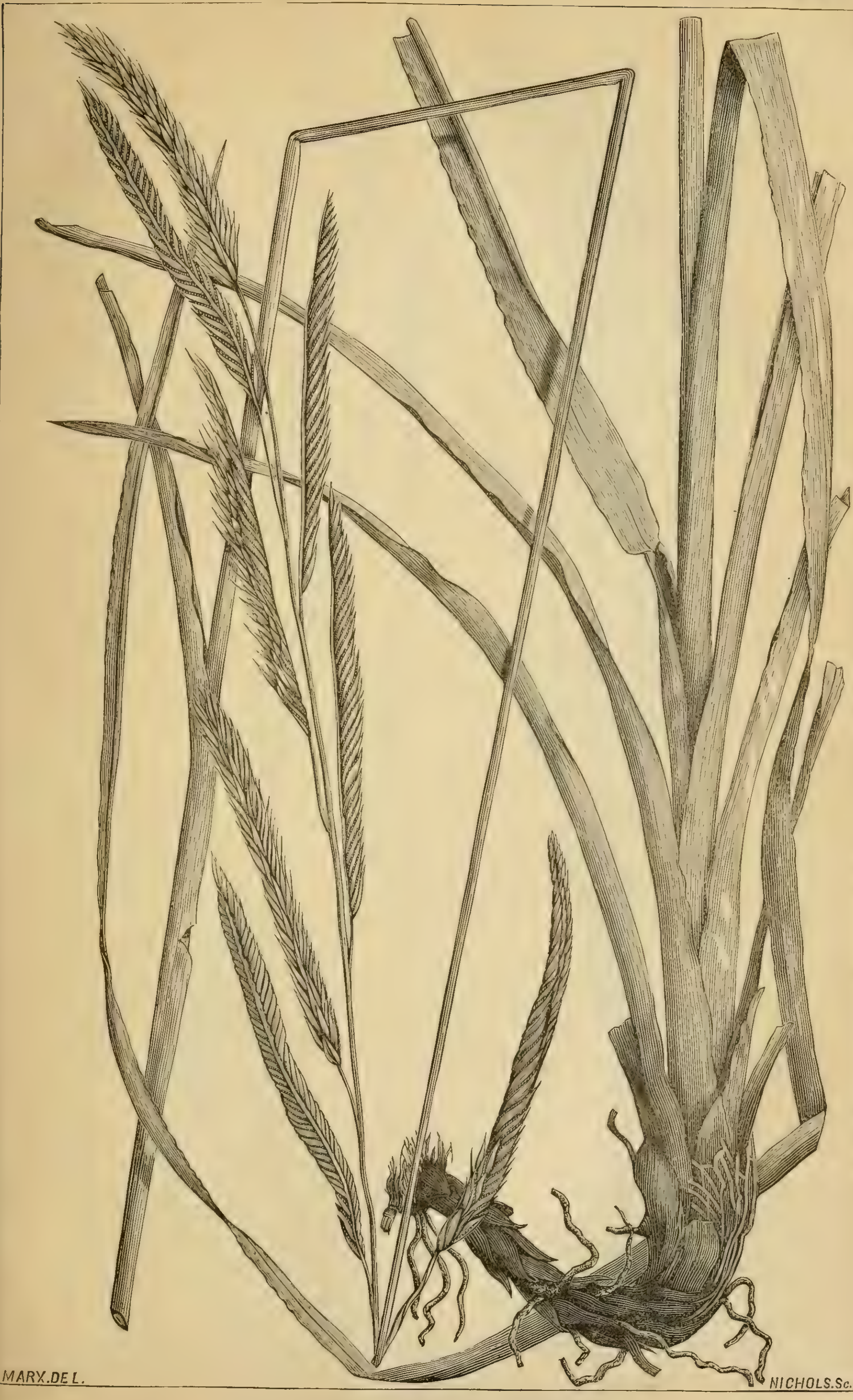
PHALARIS INTERMEDIA.

ANTHOXANTHUM ODORATUM.

DACTYLIS GLOMERATA.

MARX DEL. NICHOLS. SC.

BOUTELOUA OLIGOSTACHYA.

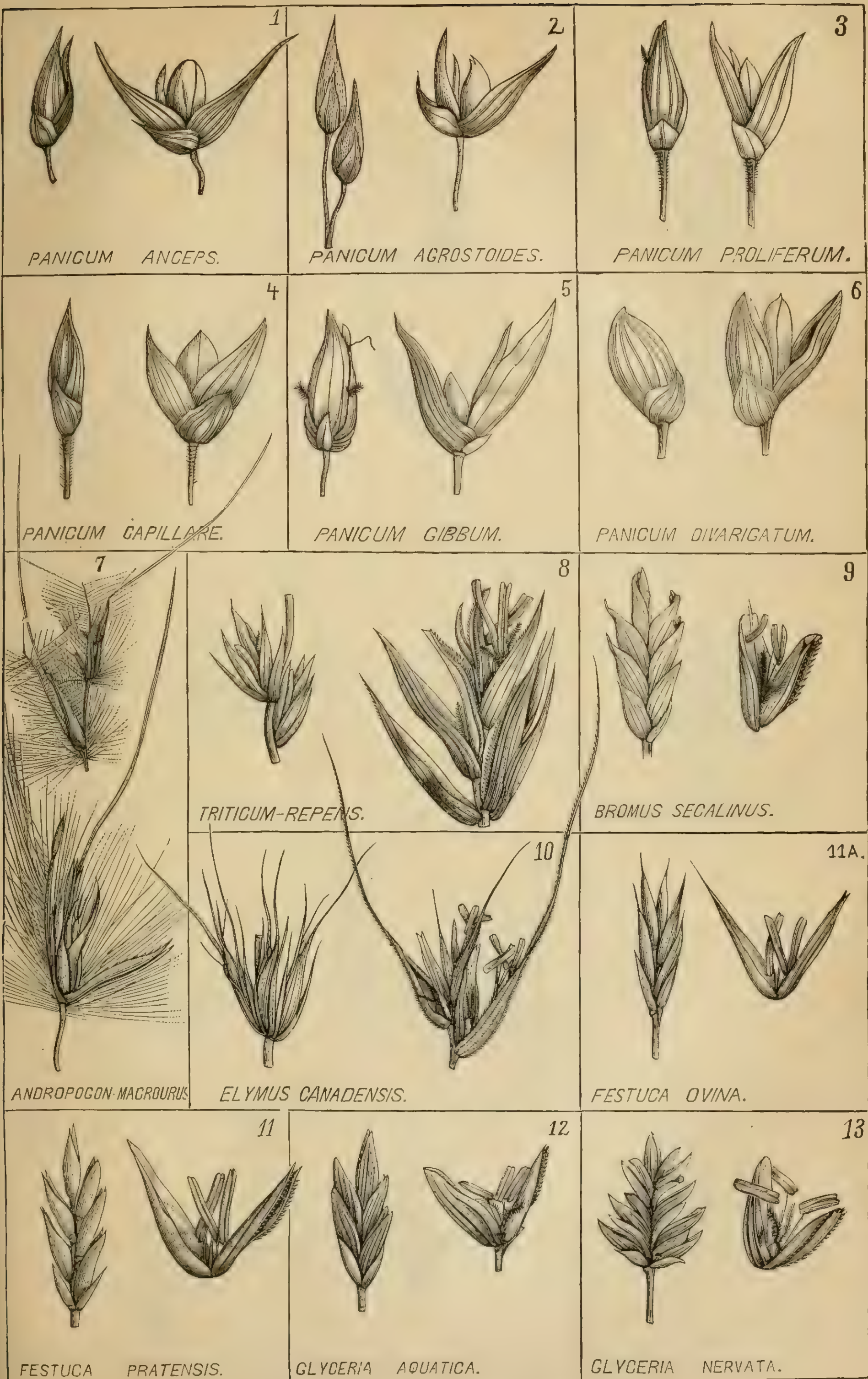


MARY.DEL. NICHOLS.Sc.

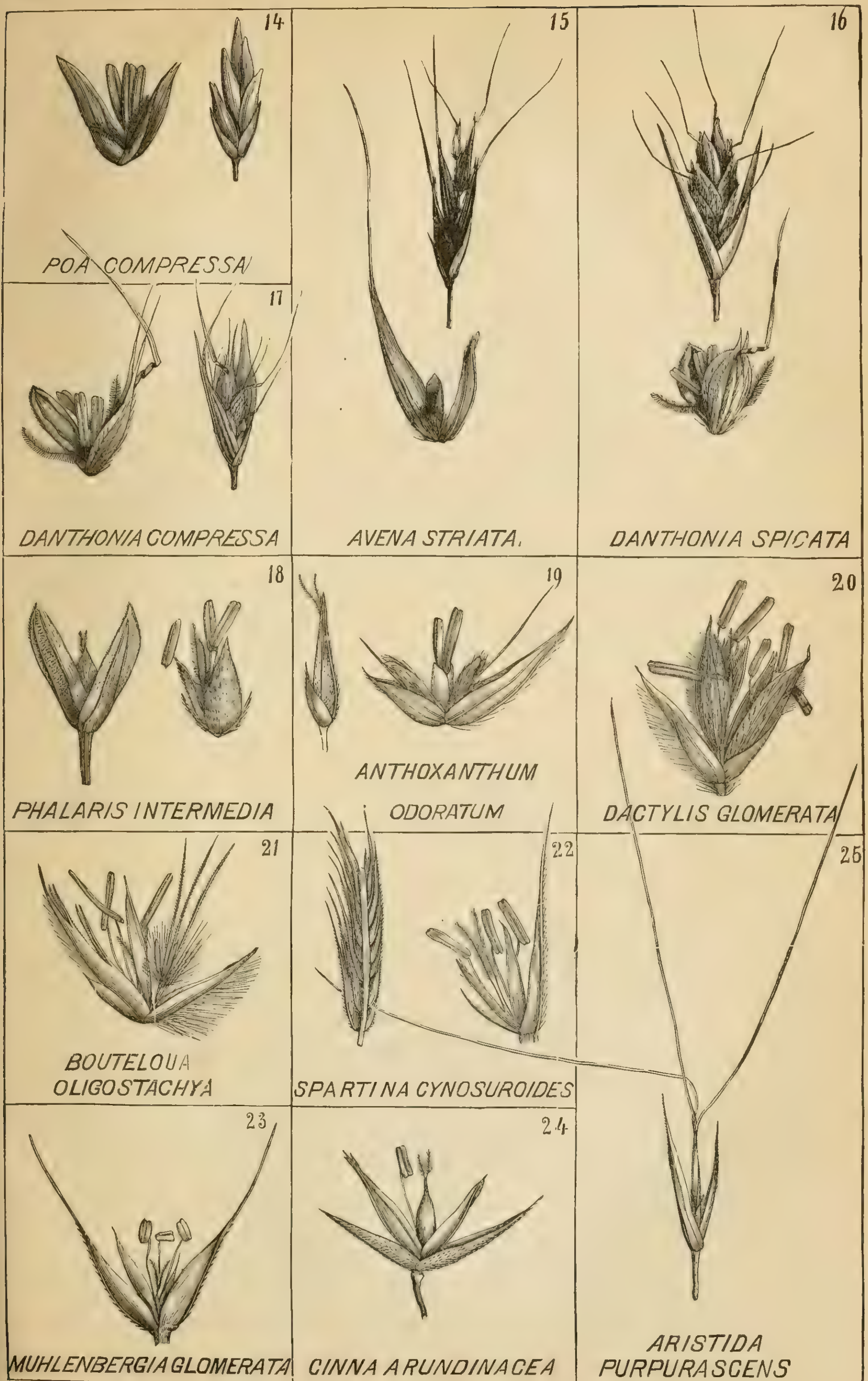
SPARTINA CYNOSUROIDES.

CINNA ARUNDINACEA.

ARISTIDA PURPURASCENS.



DISSECTIONS OF THE GRASSES.



DISSECTIONS OF THE GRASSES.

much shorter than the flowers, which are somewhat distant from each other; both palets are strongly fringed, the lower one 2-cleft at the summit, with its mid-rib extended into a short awn.

This grass apparently has little practical value.

ARISTIDA PURPUREA—Purple Awned grass.

There are many species of this genus, most of which grow in dry sandy or barren soils, and are of little or no agricultural value.

The species which we figure, *Aristida purpurea*, is one which grows west of the Mississippi River, and is common and in many places abundant on the plains of Kansas, New Mexico, and Texas.

It is an annual grass, 1½ to 3 feet high, with slender culms, much branched from the base, and short, involute leaves. The panicle is 6 to 8 inches long, rather narrow, and when in flower having a graceful, plume-like look from the spreading of the long purple awns or beards of the flower. The spikelets are 1-flowered. The glumes are unequal, the upper one being about ½ inch long, the lower two-thirds as long, and both very narrow with long tapering points. The lower palet is narrow and involute or rolled together around the upper palet and the grain or seed, and running out at the apex into three slender, diverging, nearly equal awns or beards, from 1 to 2 inches long.

Where this grass is abundant it furnishes an inferior grazing, but by enriching the soil its place can be supplied with much more valuable kinds. (See Plate XXV.)

Respectfully submitted.

GEO. VASEY, *Botanist.*

Hon. WM. G. LE DUC,
Commissioner of Agriculture.

REPORT OF THE SUPERINTENDENT OF GARDENS AND GROUNDS.

SIR: I have the honor to submit the following report in connection with the operations of this division.

The distributions for the year have aggregated to the number of one hundred and ninety-five thousand plants of various kinds, but almost wholly of those having economic value, as the olive, Japan persimmon, tea, coffee, *cinchona*, orange, lemon, fig, grape, strawberry, &c. Fully seven-eighths of these plants were distributed by mail, involving much labor in their preparation for this mode of transportation.

Estimating these plants at the very low price of 5 cents each, they would represent a money value of $9,750, a sum considerably above the amount of the appropriation allowed for labor for propagating, and for keeping the gardens and grounds of the Department in order, which includes 25,000 square feet of glass structures well stocked with plants and 40 acres of ground, much of it kept as lawn and flower-garden, with numerous walks and drives, together with collections of grapes, strawberries, and other hardy fruiting plants, all of which require much labor and attention for ordinary care and keeping.

But little has been added to the arboretum collection during the past year. The proximity of the grounds to the city, and their almost unprotected condition, render it a difficult matter to maintain the labels

on the trees and shrubs. A proper substantial fence is greatly needed to inclose the grounds and insure greater certainty in the results from propagating operations. When unprotected from depredators, no absolute certainty can be guaranteed in preserving the nomenclature of the plants in the cutting-beds, in consequence of the liability of the labels being displaced beyond the possibility of accurate readjustment.

FIGS.

In the ordinary winters here, fig trees are killed to the ground even when the young wood has been as perfectly matured as the climate will admit. The branches can be preserved by bending them down and protecting them by a covering of soil. But occasionally early frosts will destroy the foliage and arrest growth before the wood has become matured; in this condition covering is of but little avail. Towards the end of October of the present year the thermometer indicated 18 degrees of frost, which amount of cold had the effect of destroying the yearly growths on all the varieties in the collection, and in the case of young plants killed them completely. To guard against such casualties in future, and to insure a supply of cuttings for distribution, a glazed structure has been assigned to the growth of a small but select collection of varieties of the fig. The house is *single-roofed*, and the plants are trained against the wall. The object here being more for the purpose of procuring shoots for cuttings than that of procuring quantities of fruit, the border for the roots is kept well enriched so as to encourage a luxuriant growth of wood, the ripening of which can be secured by withholding water from the border as winter approaches.

In northern localities where the fig will not endure the winter unprotected, it will be found profitable to cultivate them under glass. The care of a fig house is much less than that required for a cold grapery, and the crop quite as certain and more valuable to those who fully appreciate the value of fresh figs. With a judicious selection of varieties the plants would bear continuously during summer; each plant ripening two crops of perfect fruit would afford a daily supply for many months.

The soil for fruiting figs should not be made rich; a gravelly or sandy loam, rather poor than otherwise, will produce the best results. A rich soil encourages a heavy wood-growth at the expense of the crop of fruit.

FOREIGN GRAPES.

A large collection of foreign grapes is cultivated in the grape house, mainly for the purpose of furnishing wood for propagating plants. The young plants are distributed principally in Florida and Texas, in which States some of the varieties are said to succeed in the open air quite as well as they do in California.

A brief description of some of the more recently introduced varieties is herewith given:

Mrs. Pince's Black Muscat.—This grape is represented as a late fruit of much merit, and keeping a long time after being ripe. After fruiting it for several years, it proves to be of but little value. The berries set very irregularly, and in consequence the bunches are imperfect. It is only medium in point of flavor, and is not distinguished for keeping-qualities after ripening.

Madresfield Court.—A free-growing, prolific variety. The fruit is juicy and not high flavored. The berries are liable to crack open and decompose as they ripen, unless the soil is quite dry. It is not of particular value.

Primais Frontignan.—The flavor of this variety is fully equal to that of the better known White Frontignan. It is a remarkably prolific variety, and is an acquisition among free-growing high-flavored grapes.

Muscat Hamburg.—This variety is considered to be the same as the *Black Muscat.* Comparing the two varieties as they grow side by side they closely resemble each other. The *Black Muscat* appears to have better-colored and more compact bunches. This is one of the best-flavored black grapes in the list, and when well grown produces very fine bunches.

Foster's White Seedling.—A very productive early grape of the *Sweetwater* class. It is not high flavored, and is no improvement upon older varieties. It is, however, admirably adapted for pot-culture, being a great bearer, and of very moderate growth.

Dutchess of Buccleuch.—A free-growing and productive plant, producing long tapering bunches with small white berries. It is a pleasant-flavored fruit, but does not come up to description as possessing exquisite flavor.

Early Smyrna.—An abundant bearer, of the *Sweetwater* class of grapes; fruit of sweet, spicy flavor.

Royal Ascot.—This grape promises to be a desirable acquisition to the cold grapery. It produces a medium-sized bunch, the berries large, solid, crisp, and well flavored.

Trentham Black.—A very prolific variety. The bunches are of medium size, resembling those of the *Hamburg Muscat;* the berries juicy and sweet, but not highly flavored.

Ingraham's Prolific.—A small, early, black grape, sweet and full of a brisk spicy juice, not worthy of place in a house, but promising as a good grape for some portions of the Southern States.

Napoleon Muscadine.—A free-growing, prolific vine; fruit resembles that of the *Royal Muscadine*, but much more distinct in flavor than that old variety. It possesses all the characteristics of a good table grape.

Reeve's Muscadine.—This is an early variety of the *Sweetwater* class, very productive, and of fine flavor.

Lady Downes.—This is a valuable, late-keeping grape. It succeeds very well in a cold grapery, but requires a cool night temperature when the seeds are forming, otherwise the berries become scalded, turn black, and decay quite rapidly. It is late to ripen or color, and cannot be managed properly unless the grapery is provided with a heating apparatus of some kind. With proper care the fruit can be kept hanging on the vine until March and April. The fruit is not of the highest flavor, and beyond its remarkable keeping qualities has no particular merit.

White Lady Downes.—Resembles the last in all respects except in color; it is the best-keeping white grape in cultivation.

Muscat St. Laurent.—A very prolific variety; bunches long, tapering, and slightly shouldered; a tender-fleshed fruit, but not highly flavored.

Marchioness of Hastings.—A good grape, resembling the *Black Hamburg*, but not superior to that well-known variety.

Dr. Robert Hogg.—This grape closely resembles the *Royal Muscadine*, and is about equal to that variety in flavor and productiveness.

Among the older varieties may be mentioned the *Frontignans*, white, black, and grizzly; of these, the white is the best; and as the flavor is the same in all, one variety is sufficient in a collection for family use. It is also one of the best for culture in pots.

Muscat of Alexandria.—This standard variety is well known for the large, exquisitely-flavored fruit which it produces. When cultivated in cold graperies the pollen seems to be imperfectly developed, and con-

sequently the bunches are frequently irregular and thin. A variety, the *Bowood Muscat*, usually sets more perfectly, and is preferable on that account. The *Tottenham Park Muscat* also sets very regularly. The flavor of these varieties is similar to that of the first mentioned.

Muscat Troveren.—A free-growing, prolific grape; bunches long and well formed; flavor sweet and pleasant, but without any of the peculiar excellence of the *Muscats*.

Black Hamburg.—This excellent grape is one of the most productive and reliable; it has been grown of a large size; the berries are large, of a full sweet flavor when properly matured. Many persons allow too many bunches to remain on the plant, which, in consequence, never color black or reach full maturity of size or flavor. Severe summer pruning produces a like result; and when this is combined with a heavy crop, the fruit is comparatively worthless.

The *Mill Hill Hamburg* is sweeter than the old variety. The *Wilmot Hamburg* has a larger berry; but none of the varieties of the Hamburg are essentially distinct.

Black Prince.—A standard variety for the cold grapery; the vine is free-growing and prolific; the bunches long and tapering, and slightly shouldered; the berries about medium in size; flavor pleasant and rather sprightly.

Black St. Peters.—A very desirable vine, producing freely of long, tapering bunches, which are sometimes heavy-shouldered when the bunches are large; the fruit is brisk flavored, and keeps well for a long time after becoming ripe. It is a good sort for a cold grapery.

Prince Albert.—A very robust-growing vine; consequently it does not come into bearing so early as most varieties, but when it commences to fruit it is very prolific. The bunches are very large; the berries of medium size, having solid flesh, but without any distinctive character as to flavor. It is valuable on account of its lateness, its showy appearance, and productive qualities.

Buckland's Sweetwater.—This variety produces a larger bunch and berry than does any others of the so-called *Sweetwater* class. It is a very beautiful grape, and of good flavor when ripened to a golden color, but it is not of the best class of flavored varieties.

Palestine.—This variety is sometimes grown for the novelty of its long bunches, which occasionally reach a length of 30 inches. The berries are small, hard-fleshed, but sweet and palatable. Perhaps the best use that could be made of this grape would be to cross it with a superior-berried sort, and thus secure large-bunched varieties.

Chasselas Musque.—This is one of the highest flavored of all grapes; it is, however, so liable to crack (the berries burst and decay just previous to ripening) that it is not a profitable grape to plant. In pot culture it answers better, as the fruit can be preserved and ripened by keeping the plants rather dry during the period of ripening.

White Nice.—This grape produces very large bunches; the berries are of medium size, and, when ripened, of an amber color, are sweet-tasted, but not high-flavored. The berries are prone to rot and decay should the soil in which the plants are growing become wet at the time of maturity.

Sultana.—A seedless grape, said to be the source of the Sultana raisins of commerce. The vine is of vigorous growth, and bears profusely of medium-sized bunches of small berries, which are sweet. It is not worthy of culture under glass.

Raisin de Calabrica.—A very strong-growing vine, producing large bunches, the berries of a fine golden color when ripe. Bunches weigh-

ing over 25 pounds have been produced. The fruit keeps for a long time after it has ripened, but it is scarcely of second-rate quality.

Golden Hamburg.—This forms a fine-looking bunch of large-sized berries. It is also a good-flavored fruit when it reaches the golden-colored state. It is a late-ripening kind, and desirable for a grapery.

Zinfindal.—A hardy, vigorous vine, and very productive. The bunches are long and slightly shouldered; berries medium-sized, and possessed of a brisk, vinous flavor.

Purple Damascus and *Purple Hamburg* are not worthy of culture. The fruits have no particular merit, and the bunches are usually irregular, and the berries ripen unevenly.

White Tokay.—A very showy fruit, bunches large, and berries above medium size. When well ripened the fruit is well flavored, but the berry is liable to decay during damp weather. It can readily be dispensed with for better kinds.

Royal Muscadine.—A fine early grape; it is among white varieties what the *Hamburg* is among black varieties, a sure bearer and always reliable. The bunches are of good size, and the fruit of good flavor. It is one of the best white grapes for a cold grapery.

Charles Duhamel.—An early ripening grape of the *Sweetwater* type. This grape represents a class which may possibly prove profitable in many of the Southern States, as early marketable white grapes.

Muscatel.—This belongs to the same type as the last, but is much superior in flavor, and is an abundant bearer.

PROPAGATING NATIVE GRAPES.

For the past few years most of the grapes raised in the garden have been propagated in beds in the open air. Hard, well-ripened wood is selected and made into cuttings, which are each about 4 inches in length. Whether the cutting contains one bud or eye, or more, is not important, and if a single eye can be obtained with 3 inches of wood attached, it is considered a good cutting, although lengths which are under 3 inches are looked upon as uncertain should the weather during the early portion of summer prove to be hot and dry.

The ground is prepared by turning it over to a depth of 12 inches in the fall, leaving it as rough as possible, so that it may be effectually permeated by frosts. As early in spring as the ground can be worked, the surface is carefully forked over, and broken up as minutely as practicable; it is important that the soil should be deeply pulverized.

Previous to inserting the cuttings the surface is further broken by using a rake having iron teeth four inches in length. This operation does not consist in merely raking over the surface, but in pushing the rake to and fro to the full length of the teeth, so as to thoroughly comminute the soil as deep as they will reach.

The beds are marked off in breadths of 10 feet with 3 feet wide alleys between. The cuttings are inserted in rows across the beds; they are placed about 2 inches apart, and the rows are formed about 6 inches from each other, so as to admit of a narrow hoe to be run between them.

To avoid tramping on the soil, a wide board is used to stand upon while planting the cuttings. The whole of the cutting is pushed into the soil, so that the upper bud or end (the cutting being closely cut above a bud) is level with the surface.

The bed is afterwards covered over with a layer half an inch in depth, consisting of a light friable soil; pure sand may be used if nothing better can be procured; a mixture made of one part sand and one-half

rotted tan-bark is preferable to the pure sand; swamp muck, dried and pulverized, so that the finer portions of it can be secured by sifting, forms the very best material for this purpose. In the garden of the department the sweepings of the streets are sifted and used with good results.

When the buds of the cuttings commence to swell, an additional half inch or more of the covering is evenly distributed over the surface. The young shoots push vigorously through this surface dressing, and it serves as a mulch to retain moisture during summer. Although the cuttings are rather closely set, owing to the limited area of the grounds, yet the largest portion of the plants are sufficiently strong for permanent planting when one year old.

CAÑAIGRE.

In the report of the department for 1878, at page 119, will be found an analysis of the above-named root. The main object of the examination was to determine the amount of tannic acid contained in this root, which was received from Texas, where it has long been used by the Indians and others for tanning purposes, and is said to be used at present by several tanneries in and about San Antonio. From the analysis it appears that the root contains about 23 per cent. of tannic acid, and the fact that the article is employed in tanneries would seem to indorse its practical adaptability as a tanning material.

Cañaigre is the bulbous root of a kind of dock specifically called *Rumex hymenosepalum*. It grows plentifully in sandy soils over a large territory on both sides of the Rio Grande, and from there northward over a large portion of Western Texas. The bulbs are produced in clusters like some kinds of sweet potatoes, some clusters weighing several pounds, and can be procured, it is stated, at a cost not exceeding $1 per 100 pounds.

The leaves of the plant are somewhat fleshy when in the young state, when they are greedily eaten by cattle, and occasionally used as a pot-herb by travelers and others.

Roots planted last year in the grounds of the department made only a feeble growth before the leaves decayed. They started into growth quite early last spring, and were slightly covered during several nights of heavy freezing weather. They were not perceptibly injured by the cold, and as the season advanced the plants made a favorable growth, throwing up robust flower stems, which blossomed freely, and, although the seed vessels formed, the seeds failed to mature before the leaves turned yellow and decayed, the plants resuming the deciduous state.

It is probable that the plant naturally starts into growth very early in spring and rapidly matures, after which the leaves die, the root bulbs probably remaining in the so-called dormant condition for many months. The plant evidently requires a climate where the winter is short and not severe, and a dry, warm, sandy soil.

WILLIAM SAUNDERS,
Superintendent of Gardens and Grounds.

HON. W. G. LE DUC,
Commissioner of Agriculture.

RUMEX hymenosepalus, Torr.
(CANAIGRE.)

INVESTIGATION OF SWINE PLAGUE.

INTRODUCTORY.

In the further investigation of swine plague Dr. Detmers finds but few additional symptoms worthy of mention. As his observations extended through the winter he was enabled to observe the disease closely during those months when it is neither so general nor so fatal as during other seasons of the year. During the winter months, therefore, and in the early spring, he found bleeding from the nose and symptoms of respiratory disorders quite frequent, but there seemed to be fewer indications of gastric disorders than he had observed during the summer and fall months. Neither was the prognosis, as a rule, so hopeless in the winter and spring as during the summer and early autumn. This he regards as attributable to the fact that during the former seasons the seat of the morbid process is limited more frequently to the respiratory organs and to the pulmonal tissue, and is not found so often in the intestinal canal. Thirty additional *post-mortem* examinations failed to reveal any new morbid changes worthy of special mention. A few variations, and in some cases an unusual combination of morbid changes, were observed, which will be found accurately described in the text of Dr. Detmers' report. The absence of worms or entozoa in 75 per cent. of the whole number of animals dissected prior to December 1, and their entire absence in every animal examined between that date and the 15th of the same month, would seem to prove conclusively, Dr. Detmers thinks, that the morbid changes characteristic of swine plague cannot be attributed to the work of entozoa. He thinks, however, that the presence of worms in large numbers, occurring in weak, poorly-kept, and neglected animals, may cause considerable mischief, and sometimes occasion death, but in such cases the cause should not be attributed to swine plague.

Former experiments seemed to fully demonstrate the fact that swine plague is an infectious and contagious malady, and that it is easily communicable from one animal to another by means of direct inoculation, and by the introduction into the digestive organs of the infectious principle by means of food and drinking water; second, that an exceedingly small quantity of the virus or infectious principle is sufficient to produce the disease; third, that the period of incubation does not exceed fifteen days, and lasts on an average from six to seven days; fourth, that the small microphytes (*bacilli*) found in all the morbid products, in the blood and other fluids, and in all excretions of the animals, would seem to constitute the infectious principle of the malady. This being the case Dr. Detmers instituted a series of experiments in order to determine, if possible, first, whether the infectious principle consists solely in the *bacilli* and their germs; second, whether an animal that has recovered from the disease has gained immunity from a second attack; and, third, whether the affection can be transmitted to other classes of domesticated animals. The result of these experiments proved, first, that an inoculation with *bacilli* and bacillus-germs cultivated in so innocent a fluid as milk will produce the disease with just as much certainty as an inoculation with pulmonal exudation from a diseased or dead hog; second, that an animal that has been afflicted with the plague

has not lost its susceptibility, but may contract the disease again, though probably in a milder form.

In order to test the susceptibility of other animals to the contagion, Dr. Detmers inoculated two heifers with the virus of swine plague, and the elevation of temperature and the subsequent *post-mortem* examination would seem to indicate that the disease prevailed, at least in one case (heifer No. 2), to a considerable degree of intensity. The autopsy revealed distinctly limited (circumscribed) hepatization at several points in both lobes of the lungs, each single patch comprising only a few lobules, but these were distinct and well defined. The most extensive hepatization was found along a larger bronchus in the posterior part of the left lobe. The hepatized parts or patches amounted to about 4 or 5 per cent. of the whole pulmonal tissue. The mucous membrane of the bronchiæ was found to be slightly swelled; a small quantity of serum was found in the pericardium and in the chest, and a few ounces also in the abdominal cavity. The lymphatic glands of the chest, and those belonging to the mesenterium, were enlarged, and some of them, especially the latter, to a considerable extent. The other organs exhibited no abnormal changes. The result of this experiment indicates that while cattle are not as susceptible to this plague as swine, yet it may be transmitted to them, in a mild form, by direct inoculation.

Many illustrations are given of the manner in which the contagious principle is transmitted from herd to herd and from farm to farm. Believing that the seeds of the disease consist in the *bacilli* and their germs, as fully described in his former report, Dr. Detmers is of the opinion that these microphytes can be conveyed from one place to another, not only in the morbid products of the disease, such as the tissues, fluids, and excretions of affected and dead animals, but also by adhering to and contaminating inanimate objects, both fluid and solid, and independently of any vehicle, through the air to a distance of a mile if the conditions are favorable, and in the water of running streams. The last mode is one of the most prolific sources of infection, as these microphytes propagate and multiply in water, especially if it should be contaminated by a mixture of organic matter. After citing many cases in illustration of the various ways in which the contagion is spread, Dr. Detmers is of the opinion that the following facts have been established:

First. The plague is not easily communicated unless the infectious principle is introduced either into the digestive apparatus with the food or with the water for drinking, or directly into the blood through wounds, sores, scratches, or external lesions.

Second. That the carcass of an animal that has died of the plague will communicate the disease to healthy swine if eaten before it is thoroughly putrified.

Third. That even severe frost is not sufficient to destroy the infectious principle if the same is protected against external influences by some organic substance. Former experiments by Dr. Law also demonstrated this fact.

Fourth. That the plague is readily and frequently communicated to healthy animals by means of the water used for drinking, especially if the same should be contaminated by the carcass of an animal that has died of the disease, or by the excrements, urine, nasal discharges, saliva, &c., of animals afflicted with the malady.

Fifth. That in localities where the plague is prevailing, every wound, scratch, or sore on the surface of the body constitutes a port of entry for the infectious principle.

Sixth. That old straw stacks and other decaying porous bodies may

preserve the infectious principle for months, and in many cases even for a whole year.

Seventh. That the infectious principle enters the animal organism and communicates the disease more readily through external sores and lesions than through the digestive canal.

Many experiments were instituted for the purpose of determining upon a system of preventive measures and of testing the value of certain remedial agents. As to the result of these experiments and the conclusions deduced therefrom, the reader is referred to the detailed report of Dr. Detmers.

When Dr. Law closed his former report he had just commenced some important experiments for the purpose of determining the susceptibility of other animals to swine plague. These experiments resulted, as he had previously foreshadowed, in the successful inoculation of sheep and rats, and in the transmission of the disease from these animals back to swine in a virulent and intensified form. His first experiment was undertaken for the purpose of determining at what period or stage of the malady it is most easily and certainly transmissible from one animal to another by cohabitation. In his previous report an experiment of this kind was furnished, and a deduction made that the disease was most virulent when at its height, inasmuch as the exposed pig seemed to resist the contagion from an animal in process of convalescence, but within twelve days fell a victim to the disease when placed alongside of a pig in which the malady was rapidly advancing. In the accompanying report the necropsy of this pig is given, from which it will be observed that it was afflicted with the plague in an intensified form.

The autopsy of an infected lamb, noticed by Dr. Law in his former report, is also given in full. The intestinal irritation and catarrh, shown in the tenderness of the anus and the mucus discharges accompanying the feces, together with the elevated temperature and large lymphatic glands, presented much in common with the affection in the pig. The marked eruption in the ears might be accepted as representing the skin lesions, so common in swine suffering with the plague. The more characteristic lesions revealed by the *post-mortem* examination were the purple mottling of the liver, kidneys, and heart, the grayish consolidation of portions of the lungs, and the deep pigmentation of the lymphatic glands in general.

The next experiment was that of a merino sheep infected by inoculation. The record and the results of the autopsy are very similar to those furnished by the lamb. Here, again, the principal changes consisted in purple mottling of the liver and heart, and the deep pigmentation of the lymphatic glands. Dr. Law is of the opinion that the yellowish-brown coloration of the kidneys in this case implied antecedent changes, probably of the nature of inflammation or extravasation.

From virus taken from these animals Dr. Law successfully inoculated a pig. The pig was inoculated twice, at an interval of fifteen days, with mucus from the anus of the infected sheep, and with scabs from the ear of the lamb. Enlarged lymphatic glands were observable before the last inoculation, and six days after there was a febrile temperature and the more violent manifestations of the malady. The following characteristic lesions were revealed by the necropsy, viz: The intestines contained patches of congestion; the follicles were enlarged, and the rectum ulcerated; purple discolorations were present in the liver, kidneys, and heart; the lymphatic glands were enlarged and congested by a deep red, in some cases almost black. While the evidence of the presence of the disease in this case was quite positive, in order to confirm

it beyond question, Dr. Law inoculated a second pig from virus taken from the first. This inoculation was successful. While followed by but a slight elevation of temperature, all the other characteristic symptoms of the disease were well marked. The *post-mortem* examination was made on the twelfth day after the inoculation, when the usual lesions of the plague were found. The red and black blotches on the skin were extensive, the ears blue, the intestines extensively congested, with enlarged follicles in the cæcum and colon, and blood extravasations and ulcers in the rectum. Purple discolorations and petechiæ were numerous on the liver, kidneys, and heart, and finally the lymphatic glands in general were in part congested of a deep red, and in part pigmented as the result of a previous congestion.

Another successful inoculation of a pig was made from virus from an infected lamb. The pig was inoculated from material taken from the swelling in the axilla (near the seat of inoculation) of the lamb. The inoculation produced fever, with the general malaise, moping, peevish grunt, inappetence, and the cutaneous blotches of swine plague. The animal was killed on the eleventh day after inoculation, when the autopsy was at once made. The skin showed a number of red and purple blotches, and was covered with the black unctuous exudation so frequently observed in this disease. The bowels contained patches of congestion, the cæcum and colon were enlarged, and the follicles and the rectum were ulcerated. The liver, kidneys, and heart contained the usual purple blotches. Finally, the lymphatic glands in the abdomen were enlarged and congested of a deep red or black, and those in the chest and guttural region were darkly pigmented. This was regarded as a most unequivocal case, and fully confirmed the position heretofore taken by Dr. Law, viz., that the virus of swine plague may be transmitted through the sheep and conveyed back to the pig with active and deadly effect.

This experiment was followed by the inoculation of a pig with virus from infected rat and lamb, and also inoculations with virus from infected pig, rat, and lamb. By reference to the first experiment it will be seen that while the pig showed but little elevation of temperature, there was a purple cutaneous eruption of the skin on the fifth day and enlarged glands on the twelfth, when it was inoculated with bloody mucus from the anus of the infected lamb. After this the symptoms became much more severe, and when killed, twenty-two days after, the animal showed unmistakable lesions of the disease.

The next subject was that of a healthy female Suffolk pig. This was inoculated with albumen which had been charged with a drop of blood containing bacteria drawn from an infected pig. For fifteen days nothing more was shown than a few purple spots and patches on the rump, tail, and hocks. The subject was then reinoculated with the congested intestine of the rat which had died two days after inoculation. The intestine had been frozen over night. For thirteen days more the same equivocal symptoms continued. A third inoculation was now practiced, this time with bloody mucus from the anus of the lamb. Twenty-two days after this inoculation the pig was sacrificed, but beyond some pigmentation of the lymphatic glands presented no distinct lesions that could be held characteristic of the specific fever.

On February 5, 1879, Dr. Law inoculated a rat with virulent matter that had been preserved for seventy-eight days closely packed in dry wheat brain. The rodent was preserved for thirteen days, when it was killed and immediately dissected. The symptoms during life and the lesions found after death were so closely in keeping with those of swine plague,

that there seemed no reasonable grounds for doubting the entire success of the inoculation. In order to confirm this, however, and place the matter beyond doubt, the following experiment was undertaken: On February 19, 1879, a healthy pig was inoculated with the congested lymphatic glands and lungs of the above-mentioned rat. On the sixth day after inoculation there was much malaise, with redness of the skin and the appearance of the black unctuous exudation on the ears and legs. These went on increasing, and black spots and patches, ineffaceable by pressure, appeared on the inside of the thighs and hocks. The subject was destroyed on the twentieth day, and showed the usual symptoms of the disease. The lesions were as unequivocal as in any case where inoculation was made from a sick pig direct, and would seem to prove conclusively that the rat is capable of containing this disease and of conveying it back to the pig.

The above is a brief *résumé* of the results of the more important experiments undertaken and completed by Dr. Law after the closing of his report last season. In view of the recent discoveries of M. Pasteur and other eminent scientists in inoculations for charbon and anthrax, a brief mention of which is made in Special Report No. 22, Dr. Law is now engaged in a like series of experiments to determine if diluted inoculations will not produce swine plague in a mild form and in such manner as to guarantee immunity from a second attack.

SECOND REPORT OF DR. H. J. DETMERS, V. S.

Hon. WM. G. LE DUC,
Commissioner of Agriculture:

SIR: After I sent you my supplemental report, dated December 1, 1878, you ordered me to go to work again and complete the investigation of swine plague, begun under your directions on August 1, 1878. In compliance with this order I at once started for a field of operations, and arrived at Dixon, Lee County, Illinois, on December 26. After a brief survey I established my experimental station at Gap Grove, a small village six miles west of this place, and at that time the center of an infected district. I remained there until February 8, 1879, when you ordered me to the Union Stock Yards of Chicago, to inspect cattle. My investigation, in consequence, was thereby interrupted, until on the 16th of May, 1879, when you requested me to resume my former work.

The results of my work in investigating swine plague from December 15 to Februry 7, and from May 18 to July 4, will be found briefly reported in the following pages: For convenience and to avoid unnecessary repetition, I shall arrange the various chapters in the same order as in my first report, and shall exclude, as much as possible, everything already stated in the latter. The following chapters, therefore, may be considered as supplementary to those of my first report.

1. DEFINITION OF SWINE PLAGUE.

Nothing new needs to be added, except that swine plague, although a disease *sui generis*, peculiar to swine, can be transferred by inoculation, and undoubtedly, also, by means of infested food and water, to other animals, such as rats, rabbits and sheep (Prof. J. Law), cattle and dogs.

2. SYMPTOMS.

I have visited thirty-two different herds, and examined a large number of diseased animals, but have very little to add to my former report. The essential differences observed are as follows: During the winter and in the spring bleeding from the nose, difficulty of breathing, and symptoms of respiratory disorders in general seem to be more, and symptoms of gastric disorders less frequent than in the summer and in the fall.

3. PROGNOSIS.

Though always unfavorable, the same, as a rule, is not quite so hope less in the winter and spring as in the summer and early autumn, probably because in the former seasons the seat of the morbid process is limited more frequently to the respiratory organs and to the pulmonal tissue, and is not found so often in the intestinal canal. Still the difference, partially due no doubt to some other causes or conditions, to be explained further below, is not a very great one, especially if it is taken into consideration that swine plague is always more fatal to very young pigs than to older animals or full-grown hogs; and that more pigs are born in the spring than at any other season of the year. Consequently, the average age of the pigs diseased with swine plague is much less in the summer than in the winter.

4. MORBID CHANGES.

Since December 15 numerous examinations (thirty-one is the exact number) have been made, but no new morbid changes not met with before have been discovered, and the combinations in which the various morbid changes presented themselves did not essentially differ from those already recorded in my first report. It will, therefore, be sufficient, in order to avoid unnecessary repetition, and to give at the same time a complete description of the various combinations of morbid changes which have come under my observation, to describe only those few cases which presented such variations as may possibly serve to throw more light upon the nature of the morbid process, by pointing out some of the probable causes of the great diversity of morbid changes found in different animals. Swine, just as well as other domesticated animals, and perhaps even more than other animals, on account of being omnivorous, and having therefore more opportunity to pick up worm-brood, are subject to being inhabited and preyed upon by various species of parasitic worms or entozoa, especially at certain seasons of the year. These worms, of course, occur just as well in those animals that are afflicted with swine plague as in those that have never been exposed to any infection; consequently they are found quite often on *post mortem* examinations.

As mentioned in my first report, some species of entozoa—*Strongylus paradoxus* (in the bronchial tubes), *Tricocephalus crenatus* (in the cæcum), and a few others—were found in thirteen animals, or at least 25 per cent. of the *post mortem* examinations made last summer and fall, prior to December 1; but no entozoa whatever could be found, notwithstanding I searched for them in nearly every examination made since December 15. The absence of worms or entozoa in 75 per cent. of the whole number of animals dissected prior to December 1, and their entire absence in every animal examined after death since December 15, proves conclusively, if anything, that the morbid changes characteristic

of swine plague cannot be the work of worms or entozoa. I will not deny that the latter, if present in large numbers, or occurring in weak, starving, and neglected animals, may be able to cause considerable mischief, and even death; but such cases must not be mistaken for swine plague. Worms or entozoa are found very often in healthy hogs and pigs independent of the morbid process of swine plague, and have no connection whatever with that disease. I therefore simply mentioned their occurrence in my first report, and did not deem it necessary to dwell on their natural history or on the damage which they may be able to do.

The most essential difference between the morbid features presented at the *post mortem* examinations previous to December 1 and those found in the animals examined in the winter and spring, consists in a more frequent affection of the large intestines (cæcum and colon) in the summer and fall, while in the winter and spring the principal seat of the morbid process was almost invariably in the organs of the chest, but especially in the pulmonal tissue. In the summer and fall, or previous to December 1, ulcerous tumors in either one or both of the large intestines, cæcum and colon, were found in about 90 per cent. of the whole number of cases examined, while in the winter and spring they did not exist in more than about 50 per cent.

This difference it seems to me is not accidental, but admits of an explanation. At any rate, the predominating affection of the organs of the chest, and especially the extensive embolism and exudation in the lungs, observed invariably in every case in which the large intestines were free from ulcerous tumors, may be traced to distinct causes, acting principally during the winter. Swine, especially in the cold season of the year, on entering their lair and going to sleep in the evening, are in the habit of crowding close together, of lying on top of each other, and of frequently passing the night in very close quarters. Such crowding into a narrow space cannot fail to heat their bodies, to vitiate the atmosphere, and to accelerate the respiration. Consequently it will prevent a proper decarbonization of the blood and retard its circulation in the pulmonal capillaries, and cause more or less congestion of the lungs, and prepare those organs for just such morbid changes as are effected by the *bacilli* and their germs. In the morning, after the animals have been heated during the night, and are rising from their lair in search of food, the air, especially in the winter, is usually cold and chilly, and, but a moment ago reeking and steaming with perspiration, they become chilled and commence to shiver. Such a sudden change of temperature necessarily causes a disturbance of the functions of the lungs and of the skin, contracts the expanded capillary vessels of the latter, and thereby compels the blood to rush to the heart and to the interior parts of the body. All this cannot fail to predispose, especially the lungs and heart, to become the principal seat of the morbid process of swine plague, if the infectious principle, the *bacilli* and their germs, have entered the organism. Moreover, it appears to be probable that an imperfect decarbonization of the blood promotes the tendency of the bacillus-germs and partially developed *bacilli* to agglutinate to each other, and to form those irregularly shaped clusters which clog the capillaries, and cause in that way extravasation of blood and extensive exudations. Some other influences may be acting, but those mentioned seem to be the principal ones. The greater frequency of morbid changes in the large intestines and in the digestive canal in general, in the summer and fall, has probably an equally good cause.

Swine as a rule lead a more independent life in the summer and fall

than during the winter. In the summer and fall a great many have access to a pasture, others are allowed to roam at large, and get their food and water wherever it is convenient, and almost all receive at least some green food. Further, the *bacilli* and their germs propagate more rapidly in the summer and early fall than in any other season of the year, and the heavy dews, common from July or August till November, carry down in the night and morning those germs that may have risen in the air during the day and deposit them upon the surface of the earth, but especially upon the grass and herbage of field and pasture, and in the water of pools, brooks, &c; consequently, there can be no doubt that an introduction of the disease-germs into the animal organism with the food and water for drinking constitutes a more frequent means of infection in the summer than in the winter. Now, according to my observations, as mentioned in my first report, the morbid process seems to have a special tendency to attack the digestive canal, and to produce ulcerous tumors in the large intestines, if the infectious principle has been introduced with the food or with the water for drinking; but this is often, though not always, confined to the organs of the chest and to the lymphatic system if the disease-germs have entered the organism through a scratch or wound.

A FEW SPECIAL CASES.

1. *Post mortem* examination of a barrow, nine months old, belonging to H. Miller, Praireville, Lee County, Illinois. Date, December 29.

Externally.—No *rigor mortis*, and carcass yet warm. Skin reddened and purplish on lower surface of body, between the legs, behind the ears, and on the neck

Internally.—Lymphatic glands enlarged; in the lungs gray hepatization and numerous embolic hearths, looking like tubercles, comprising over one-third of the whole pulmonal tissue; more than one pint of serum in the chest, and over four ounces in the pericardium, capillaries, and larger blood-vessels of the heart, but especially of the auricles, very much injected and tinged with dark-colored blood, so as to give the auricles an almost uniform black-brown appearance; extravasated blood and large quantities of gelatinous exudation imbedded in the tissue (walls) of the auricles; no ulcerous tumors in the intestinal canal.

2. *Post mortem* examination of a pig nine months old, weighing 250 pounds, and belonging to Mrs. Harms, Gap Grove, Lee County, Illinois. The animal had just died. Date, December 30.

Externally.—Blood oozing from the nostrils.

Internally.—Pulmonal and costal pleura nearly everywhere more or less firmly united; brown hepatization extending over three-fourths of the lungs; some parts almost gangrenous, and containing patches of extravasated blood; capillary blood-vessels of the heart, but especially of the auricles, very much injected, and tinged with dark-colored blood; left auricle perfectly black; blood everywhere dark-colored; lymphatic glands everywhere enlarged; some incipient ulcerous tumors in cæcum, and erosions in the mucous membrane of the blind end of the same intestine. The carcass was in very good flesh, and rather plethoric.

3. *Post mortem* examination of another pig of same age, belonging to same party. Date, January 8.

Externally.—No changes worth mentioning.

Internally.—Lymphatic glands somewhat enlarged; adhesion between pulmonal and costal pleura; one-half of the pulmonal tissue hepatized, numerous embolic hearths and extravasations of blood in the hepatized parts of lungs, and the tissue of the heart and of the posterior aorta; some serum in pericardium; auricles of the heart spotted with numerous specks of extravasated blood; flesh (fat and lean) everywhere very yellow; liver more or less sclerotic, and contents of gall-bladder very dark-colored and semi-solid; spleen dark-colored, and spotted with small rust-colored and elevated spots; small specks and patches of extravasated blood in mucous membrane of stomach; several ulcerous tumors—some very large, others small—in colon; erosions and specks of extravasated blood, but no ulcerous tumors in mucous membrane of cæcum.

4. *Post mortem* examination of a pig belonging to Mr. Swigart, Palmyra, Lee County, Illinois. Date, January 14. Pig was killed by bleeding. While alive, was bleeding from the nose, and breathing with difficulty.

Morbid changes.—All lymphatic glands very much enlarged; pulmonal pleura of left lobe of lungs adhering to costal pleura; red and brown hepatization and numerous

specks of extravasated blood in lower half and posterior part of the left lobe; in right lobe, three-fourths of the whole tissue hepatized and containing numerous specks of extravasated blood in lower half and posterior part of the left lobe; in right lobe three-fourths of the whole tissue hepatized and containing numerous specks of extravasated blood, and also an abundance of fresh and partially coagulated exudation in the pulmonal tissue, and on the surface of the pulmonal pleura. The lungs, but especially the right lobe, presented a very marked appearance—gray, brown, and red hepatization—and fresh exudation in adjoining lobules alternating with each other. Some serum in pericardium; blood in the heart and everywhere else, dark-colored, as in all animals in which the pulmonal tissue constitutes the principal seat of the morbid process; one ulcerous tumor in colon; cæcum healthy.

5. *Post mortem* examination of another pig, nine months old, belonging to Mrs. Harms. Carcass in first-rate condition as to flesh; weight 220 pounds. Date, January 18.

Morbid changes.—All lymphatic glands enlarged; pleura of right lobe of lungs partially coalesced to costal plura; fully two-thirds of the tissue of both lobes of lungs hepatized—red and brown hepatization—and containing innumerable small patches of extravasated blood and embolic hearths; some serum in thoracic cavity and in pericardium; capillary vessels of the heart, but particularly of the auricles, very much injected and tinged with dark-colored blood; numerous small red spots (extravasated blood), as large as a millet-seed or smaller, in the serous membrane of the small intestines (jejunum and duodenum); numerous large and, some of them, confluent ulcerous tumors penetrating into the external or serous membrane in cæcum; several smaller or medium-sized ulcerous tumors in colon; liver yellowish; contents of gall-bladder semi-fluid and granular.

6. *Post mortem* examination of a pig belonging to John Lord, Palmyra, Lee County, Illinois. The pig was killed by bleeding to obtain material for experimental purposes. Date, January 21.

Morbid changes.—Besides those usually found in the organs of the chest and in the lymphatic system were a profuse proliferous growth of connective tissue and epithelium cells in process of decay, presenting a profuse ulcerous tumor on the mucous membrane of the stomach at its large curvature, but no ulcerous tumors in any other intestine.

7. *Post mortem* examination of two hogs belonging to G. Sartories, near Gap Grove, Lee County, Illinois. Both animals had recovered from an attack of swine plague over two months ago, and were butchered for pork. Date, January 22. One of the hogs, No. 7, dressed 180 pounds, and the other one, No. 8, dressed 260 pounds. Both were of about the same age, and over a year old.

Morbid changes in No. 7.—Pulmonal and costal pleura connected everywhere by means of a loose and very meshy connective tissue, which could be torn without using great force; remnants of partially absorbed hepatization in anterior lobes of the lungs; firm and inseparable adhesion (union) almost everywhere between the external surface of the heart and the internal surface of the pericardium. (The animal, before it was killed, exhibited asthmatic symptoms.) No other morbid changes could be found, except enlargement of most of the lymphatic glands situated in the thoracic and abdominal cavities.

Morbid changes in No. 8.—All lymphatic glands considerably enlarged; remnants of hepatization, but yet very distinct, and inclosing two nodules (one of the size of a small cherry, and the other the size of a large pea), sequestered by an envelope of firm and solid connective tissue in the anterior parts of the lungs; no adhesion between the pleuras, and no other morbid changes. (In the chapter headed "Contagion" I shall have to refer again to these two animals.)

9, 10. *Post mortem* examination of two hogs belonging to John Lamken, near Prairieville, Lee County, Illinois. The same had been afflicted with swine plague, but had recovered over two months ago, and were butchered for pork. Both were of about the same age and size, and dressed each about 275 pounds. Date, February 3. No morbid changes in hog No. 9, except small remnants of hepatization in the lungs; and in hog No. 10 no morbid changes, except a small and unimportant scar in the cæcum, indicating the former existence of an ulcerous tumor. Both hogs undoubtedly had only a very mild attack of swine plague, otherwise more important morbid changes would have been left behind. If any exudation or hepatization had existed in the lungs of hog No. 10—and it would be very strange if it had not, because I never found it entirely wanting in any other of the numerous *post mortem* examinations I had an occaion to make (about one hundred since August 1)—it must have been perfectly absorbed, because no trace could be discovered.

11. *Post mortem* examination of a pig belonging to Mr. Horace McKay, twelve miles north of Champaign, Champaign County, Illinois. A small, evidently stunted animal, which had been sick for two months, had a large tumor of the size of a man's fist on the left side of the anterior part of its nose. The temperature of the animal, which was killed by bleeding, was 104.8° F. Date, June 17. *Morbid changes:* The tumor was hard, mainly composed of a dense connective tissue, similar to that of an intestinal ulcerous

tumor, and undoubtedly originated in the mucous membrane of the nasal cavity. Its interior concave surface, communicating with the latter, was coated with a thick layer of a dirty-white or gray-yellowish detritus, the same as coats the surface of the ulcerous tumors which occur in the large intestines. Its external surface was convex or semi-globular, dark-colored, and almost smooth.

Internal morbid changes.—Two-thirds of both lobes of the lungs hepatized; some almost clear or slightly straw-colored serum in the pericardium and in the chest; froth in the bronchial tubes; all lymphatic glands enlarged, but no other morbid changes, except a small quantity of serum in the abdominal cavity. The tumor, according to Mr. McKay, made its appearance two months ago, at the beginning of the disease.

12. *Post mortem* examination of a small pig four months old, belonging to M. Philippi, ten miles north of Champaign, Champaign County, Illinois. This animal was very emaciated, and may not have weighed over ten pounds. Its temperarure was 106° F. It had been sick four weeks, and was killed by bleeding. Date, June 24.

Morbid changes.—Small quantities of serum in the pericardium and in the thoracic and abdominal cavities; lymphatic glands enlarged; capillary vessels of the auricles of the heart gorged with dark-colored blood, and hepatization in the lungs, comprising three-fourths of the left and one-half of the right lobe.

5. EXPERIMENTS.

The experiments made previous to December 1, and recorded in my first report, have proved: 1. That swine plague is infectious, and can be communicated or transmitted from diseased hogs or pigs to healthy animals in two different ways: by direct inoculation, and by an introduction of the infectious principle, either with the food or with the water for drinking, into the digestive canal. 2. That an exceedingly small quantity of the infectious principle is sufficient to produce the disease. 3. That the period of incubation, or, more correctly, the stage of colonization, does not exceed fifteen days, and lasts on an average from six to seven days. 4. That small *Schizomycetes*, the *bacilli suis* and their germs, which are found in all the morbid products, in the blood and other fluids, and in all excretions of the diseased animals, constitute, almost beyond a doubt, the infectious principle and the real cause of the disease.

I concluded, when I went to work again on the 15th of December last, to make another series of experiments for the purpose of ascertaining with certainty, if possible: 1, whether the infectious principle consists solely in the *bacilli* and their germs; 2, whether an animal that has had the disease, and has recovered, has lost all further susceptibility, or is yet subject to future attacks; and, 3, whether swine plague can be communicated to other animals besides swine. To enable the reader to draw his own conclusions, I will first briefly relate the experiments made, and then state the conclusions I have arrived at.

On January 9 I bought two healthy pigs (which I shall designate as pigs Nos. 1 and 2) of Mr. H. Lamken, at Prairieville, and put each pig by itself in a clean and comfortable pen, which had not been occupied by any hogs or pigs for a long time. On January 17 I bought another pig, seven or eight months old, of Mr. E. Taddicken, at Prairieville. This pig had recovered from swine plague about two months before, and had become somewhat stunted in consequence of its sickness, but had a very good appetite, and did not exhibit any symptoms of existing fever or of active disease. It was designated as pig No. 3, and was put by itself in the pen occupied by pig No. 2, which latter was put in with pig No. 1.

January 21.—Charged one ounce of fresh milk, just drawn from the cow, with a mere speck of the proliferous growth of the stomach of John Lord's pig, which had been killed by bleeding. The milk thus charged, and contained in a perfectly clean two-ounce vial, closed by a tight-fitting glass stopper, was kept at a constant temperature of 90 to 100° F.

January 22.—None of the experimental pigs, so far, have shown any symptoms of

disease. All seem to be in good health. Nos. 1 and 2 are thrifty and growing. Inoculated No. 3, the one that recovered from a previous attack, in the ear, by means of a small inoculation-needle, with a little juice (less than half a drop) pressed out of the proliferous growth of the stomach of John Lord's pig, killed by bleeding for the purpose of obtaining fresh material for inoculation, so as to exclude any possibility of producing pyæmia.

January 23.—Inoculated pigs Nos. 1 and 2 also in the ear, by means of a small inoculation-needle, with the milk charged with *bacilli* and bacillus germs on January 21. Examined under the microscope, and milk, besides its normal constituents, contained numerous *bacilli* and bacillus germs.

January 24.—All three pigs apparently in good health. None of them show any symptoms of a reaction.

January 25.—All experimental pigs apparently healthy.

January 26.—Experimental pigs apparently healthy; all have good appetite.

January 27, 28, and 29.—All three experimental pigs have good appetite. No symptoms of disease.

January 30.—Pigs Nos. 1 and 3 indisposed, but have some appetite. Pig No. 2 apparently healthy.

January 31.—Pigs Nos. 1 and 3 show plain symptoms of disease, are sneezing frequently, and show a tendency to hide in their bedding. Pig No. 2 apparently all right.

February 1.—Experimental pigs Nos. 1 and 3 evidently sick, both sneeze and cough a great deal, and do not seem to have much appetite. Pig No. 2 apparently not affected.

February 2.—Experimental pigs about the same as yesterday.

February 3.—Pig No. 1 hides in its bedding, is emaciated, and has no appetite. Pig No. 3 is sick, but eats some. No. 2 is doubtful.

February 4.—All three pigs about the same as yesterday.

February 5.—Pig No. 1 has no appetite whatever, and is very poor. Nos. 2 and 3 about the same as the day before.

February 6.—Pig No. 1 about the same as yesterday. No. 3 appears to be slightly improving. No. 2 sneezes and shows other symptoms of a mild attack.

February 7.—Pig No. 1 eats a little. In Nos. 2 and 3 no visible changes.

As I was called away to Chicago, I had to leave the pigs to their fate; but in order to learn what would become of them, I left them with Mr. H. Lanken, with the understanding that he was to pay for pigs Nos. 2 and 3, should they be alive three weeks after date. Pig No. 1 was considered as not being worth anything. In due time Mr. Lanken sent me the money and a note, in which he stated that pigs Nos. 2 and 3 were alive and improving, and pig No. 1 of no account, but still alive.

I intended to subject the causal connection of the *bacilli* and their germs with swine plague to one more (negative) test by inoculating healthy animals with morbid fluids (exudations) of diseased animals after they had been freed from bacillus-germs, and filtered for that purpose some pulmonal exudation and blood serum through sixteen papers, but did not succeed. The last filtrate examined under the microscope still contained a large number of bacillus-germs or globular bacteria.

The experiments related above prove two things: First, that an inoculation with *bacilli* and bacillus-germs, cultivated in an innocent fluid, such as fresh milk, can and will produce the disease with just as much certainty as an inoculation with pulmonal exudation, or with any other bearer of the infectious principle taken directly from a dead or diseased hog. Second, that an animal that has been afflicted with swine plague, and has recovered, has not lost its susceptibility, but may contract the same disease again, though probably in a milder form. The latter fact has received further confirmation by a statement of Mr. Reinhard, an intelligent farmer and reliable observer, residing near Prairieville, who informed me that one of his hogs had been sick with swine plague three times, but had (partially) recovered after each attack, and was still living, but of not much value. Such cases would probably occur oftener, if it was not for the malignancy of the disease; the first attack has generally a fatal termination, and the usually very short life of the hog.

When called away to Chicago I was about to commence a series of experiments with cattle, for the purpose of deciding whether swine plague can be communicated to these animals, the same as of sheep and rabbits, which, I had seen stated, had been successfully inoculated by Professor James Law, at Ithaca, N. Y. Considering that question at any rate as of great practical and scientific importance, something happened while I was employed in the Union stock-yard of Chicago as inspector of cattle which made it still more desirable to settle the question as soon as possible. While there I had to inspect, from February 10 to May 16, over 300,000 head of cattle. Among that vast number I found only one animal exhibiting symptoms decidedly suspicious of contagious pleuro-pneumonia, or lung fever. The animal in question was a yearling heifer, and had come in, together with another one, in a car-load of hogs from Sublette, Lee County, Ill. It was shipped by its owner—so I learned afterwards—because it had been ailing for some time, and was not doing well. In order to decide whether those suspicious symptoms exhibited during life were those of pleuro-pneumonia, or of some other respiratory disorder, I bought the heifer and had it killed by bleeding for *post-mortem* examination. The morbid changes were as follows: The lungs filled the whole thoracic cavity so completely as to show on their surface plain impressions of the ribs. Their surface was uneven to the touch, and on further examination distinctly limited hepatization, such as is characteristic of contagious bovine pleuro-pneumonia, or lung plague of cattle, presented itself. It was most developed in the left lobe, and particularly in its anterior part, but quite large and distinctly limited patches of hepatized lobules, some gray, and some red or brown, presented themselves also when the left lobe was cut into, in its central and posterior portion. Externally the central and posterior part of the left lobe, if looked at superficially, seemed to be healthy, because the lobules next to the pleura were not affected. The right lobe, too, contained several patches of hepatization, but was on the whole, much less affected than the left lobe. I cut off some of the worst hepatized parts, and put them in a bucketful of clean water; they went to the bottom like a rock. Only one small portion of the pleura, say about three inches in diameter, and coating a portion of lung in which the hepatization extended to the surface, was coated with a slight layer of exudation. Most of the lymphatic glands in the chest and in the abdominal cavity appeared to be enlarged. No other morbid changes were found.

As hepatization in the lungs of cattle is, to say the least, an exceedingly rare occurrence except in contagious pleuro-pneumonia—in a practice of over twenty years I have never seen it except in that disease, neither have other experienced practitioners whom I have consulted (I will only name Dr. J. C. Meyer, sen., of Cincinnati, and Dr. F. W. Prentice, of Champaign, and refer to Professor Gerlach's work on Veterinary Jurisprudence)—and as Prof. James Law, of Ithaca, N. Y., had succeeded in communicating swine plague, a disease also characterized by distinctly limited hepatization in the lungs, to other animals than swine by means of inoculation, the question arose: Can swine plague be transmitted also to cattle, and, if so, what is the case in question? Is it contagious bovine pleuro-pneumonia, or is it swine plague transmitted to cattle? It was clear to my mind that if it was contagious pleuro-pneumonia, several cases, or at least more than one case, would be existing at the place where the heifer had come from; and if swine plague, some lasting and intimate contact or association with diseased hogs must have taken place. I communicated my views to John B. Sherman, superintendent of the Union stock-yard, and to Nelson Morris,

the largest cattle-dealer and exporter in Chicago, and, on consultation, it was concluded, in order to obtain certainty, to send Dr. F. W. Prentice, Professor of Veterinary Science in the Illinois Industrial University, Champaign, Ill., at once to Sublette, where the heifer had come from, to make a thorough and searching investigation. Until his return, and the contrary had been proven, the worst of the two possibilities had to be accepted, as it was not known that swine plague could be communicated to cattle. Dr. Prentice made a thorough investigation, but failed to find any bovine pleuro-pneumonia, or any trace of its existence; he learned, however, that the heifer in question had been raised in the hog-lot, among the swine, by the same farmer who shipped her to the stock-yard, and I know that in Sublette and immediate vicinity an immense number of hogs and pigs had died of swine plague in the latter part of last fall and the early part of last winter. The absence of any contagious pleuro-pneumonia, and the fact that the heifer in question had been born and raised on the same farm from which it had been shipped, were sufficient proofs that we had not to deal with the bovine lung plague. Dr. Prentice and myself were therefore able to contradict, on his return, certain perverted statements which had been published in several papers. Still, although fully convinced that we had not to do with a case of contagious bovine pleuro-pneumonia, we had not sufficient proof to authorize us to pronounce the morbid changes in question the product of transmitted swine plague.

When, in compliance with your order, I resumed the investigation of swine plague in May, which had been interrupted in February, it was one of my first attempts to ascertain by experiment whether swine plague can be communicated to cattle or not. On May 26 I bought two healthy heifers, one a common scrub, and about eight or nine months old, and the other a half-breed Jersey, about four months old. The latter, designated as heifer No. 1, was kept in a good pasture on the same farm on which it had been raised, and received, besides grass, some milk while being experimented with. The former, designated as heifer No. 2, being old enough to eat hay, was kept in a good stable in the city of Champaign, and was fed with good hay, oats, chopped feed, and water. Both animals were inoculated in the ear—received each two punctures—by means of a small inoculation-needle, No. 1 with less than a quarter of a drop of blood, and No. 2 with a similar quantity of serum pressed out of an ulcerous tumor situated in the scrotum of a recently castrated pig, sick with swine plague. Up to June 5, neither of the heifers showed any symptom of disease, but it may be remarked that heifer No. 1, being in a large pasture over two miles from town, could not be visited and examined every day; but heifer No. 2, being in a stable in town, and therefore always approachable, was examined at least twice every day.

June 5.—Heifer No. 2 appears to be less lively; its muzzle is dry and warm, and the temperature (in rectum) 102.5° F. Heifer No. 1 perfectly healthy.

June 6.—Heifer No. 2, appetite changeable; muzzle dry; temperature 102.6° F.

June 7.—Heifer No. 2, muzzle moist; otherwise no change; temperature 102.4° F.

June 8.—Heifer No. 2, muzzle moist; appetite good. (Broke theremometer, and therefore failed to ascertain temperature.) Heifer No. 1 evidently all right in every respect.

June 9.—Inoculated heifer No. 2 at 5 o'clock p. m., by means of a hypodermic syringe with half a drachm of pulmonal exudation, obtained from the lungs of a pig belonging to Mr. Coffee, in Campaign. The pig was examined immediately after death, and presented all those morbid changes which are characteristic of swine plague. The injection was made just behind the shoulder-blade into the subcutaneous connective tissue. Heifer No. 1 was inoculated by the same means with one drachm of the same material. The injection was made into the loose connective tissue of the dewlap. The

exudation used was perfectly free from any putrid smell, and contained, examined under the microscope, numerous bacillus-germs, and some *bacilli*.

June 10.—No visible reaction in either animal.

June 11.—Heifer No. 2, no change, except a very slight swelling attacked by a few flies at the place of inoculation.

June 12.—Heifer No. 2, changeable appetite.

June 13.—Heifer No. 2, no morbid symptoms whatever; temperature, 102° F.

June 14.—Both heifers apparently in first-rate health.

June 15.—Heifer No. 2 shows signs of illness; breathes fifty-six times a minute; muzzle dry and abnormally warm; appetite slow and irregular; eyes somewhat dull.

June 16.—Heifer No. 2 shows at times plain indications of illness, and at times seems to be all right; coughs some; dung rather hard, dark-colored, and coated with sticky mucus. Temperature, 103.4° F.

June 17.—Heifer No. 2 evidently sick; muzzle dry and hot; appetite irregular and changeable; dung hard and dark-colored as yesterday; respiration accelerated. The animal acts rather dull, and shows a tendency to lie down. Temperature, 103.6° F.

June 18.—Heifer No. 2, in the forenoon the same as yesterday, except the temperature, which was as low as 102° F. In the afternoon apparent improvement; muzzle moist, but temperature 103° F.

Heifer No. 1, till date, has not exhibited any conspicuous symptoms of disease; at least none has been observed by Mr. Moore, who keeps the animal in his pasture, and is perfectly familiar with all the various symptoms of swine plague. Examined the animal at 9 o'clock, a. m., and found the muzzle dry and abnormally warm; the breathing accelerated, and the temperature, taken without any struggling or resistance, 103.5° F.

June 19.—Heifer No. 2, no essential change; muzzle sometimes moist, sometimes dry; temperature, 103.4° F.

June 20.—Heifer No. 2 about the same; dung of the consistency of stiff dough, and blackish in color (the food consists of very good hay, some oats, and occasionally some bran or chop-feed); temperature, 103.5° F.

June 21.—Heifer No. 2, no essential change; breathing a little more accelerated, but the eye somewhat brighter; temperature, 103.6° F.

June 22.—Heifer No. 2, no essential change; temperature, 104° F.

June 23.—Heifer No. 2, temperature in the morning, 104.4° F.; in the evening, 103° F.

June 24.—Heifer No. 2, temperature in the morning, 103° F. Inoculated the same in the evening once more by means of a hypodermic syringe with ten drops of the pulmonal exudation of Mr. Philippi's pig.

June 25.—Heifer No. 2 less lively, more dumpish than on preceding day; temperature, 103.6° F.

June 26.—Heifer No. 2, no essential change; temperatgre, 104° F.

June 27.—Heifer No. 2, about the same; temperature, 103.7° F.

June 28.—Heifer No. 2, appears to be more lively; appetite improved; temperature, 103° F.

June 29.—Heifer No. 2 eats and drinks well; muzzle moist; temperature, 103.6° F.

June 30.—Heifer No. 2, muzzle hot and dry in the morning. Took at 1 o'clock, p. m., a few drops of blood from a vein of its left ear, which, examined under the microscope, contained a few moving *bacilli* and several clusters of bacillus-germs (see drawings). The temperature, taken at the same time, was only 102° F. At 6 o'clock, p. m., respiration fifty-six breaths in a minute, and temperature 104.4° F.

Heifer No. 1, examined in the afternoon, appeared to be all right. According to Mr. Moore, it had acted dumpish and been out of appetite for a few days, but had recovered. So it may be concluded that heifer No. 1 has had a very mild attack, but its vigorous constitution has enabled it to overcome the effects of the infectious principle.

July 1.—Heifer No. 2, muzzle hot and dry; temperature 103.8° F.

July 2.—Heifer No. 2, muzzle moist; respiration accelerated; the animal breathes over sixty times a minute; auscultation reveals a slight rubbing sound, and increased bronchial breathing; temperature 104.5° F. In the evening temperature down to 103° F.

July 3.—Heifer No. 2, temperature at 9 o'clock, a. m., 103.6° F. (It may be remarked here that heifer No. 2, during the whole experiment, had a very quiet, clean, and moderately dark stall, 5×10, where she was not at all, or but very little, molested by flies, where the air was always pure, and where nothing occurred liable to raise the temperature of the body above normal; on the contrary, where the conditions were rather such as to keep the temperature at the lowest point, because the animal was tied, had no exercise, and was naturally of a very quiet and docile disposition. It scarcely ever offered any resistance while being examined.)

At 9.15 o'clock, a. m., heifer No. 2 was killed by bleeding by a professional butcher.

Morbid changes found at the post-mortem examination.—Distinctly limited (circumscribed) hepatization at several places in both lobes of the lungs, each single patch comprising only a few lobules, but very distinct and well defined. (See photograph of Plate 1, of a portion of the anterior part of the left lobe, which shows two small hepatized patches.) The most extensive hepatization was found along a larger bronchus in the posterior part of the left lobe. The hepatized parts or patches amounted to about 4 or 5 per cent. of the whole pulmonal tissue. The mucous membrane of the bronchæ was found to be slightly swelled; a small quantity of serum was found in the pericardium and in the chest, and a little more, a few ounces, in the abdominal cavity. The lymphatic glands situated in the chest, and those belonging to the mesenterium, were enlarged, some of them, especially the latter, to a considerable extent. All other organs appeared to be perfectly healthly and normal. The blood probably was a shade darker than that of perfectly healthy cattle butchered or killed by bleeding.

The experiment with heifer No. 2 has proved beyond a doubt that swine plague can be communicated to cattle by direct inoculation, though perhaps only in a mild form; 2, that cattle possess less susceptibility than swine, and are not easily infected; and 3, that the principal morbid changes of swine plague, communicated to cattle by inoculation, present themselves as hepatization of the pulmonal tissue, and are essentially the same in cattle as in swine.

Since the possibility of a communication of swine plague from hogs to cattle has thus been proved, and since it has been ascertained by other experiments that swine plague is communicated from hog to hog, not only through wounds and scratches (direct inoculation), but also with equal facility by an introduction of the infectious principle with the food, or with the water for drinking, into the digestive canal, there remains in my opinion, not the least doubt that the heifer killed in February in the Union stock-yard, which was raised in a hog-lot among diseased hogs, and compelled not only to eat and drink with diseased hogs, but probably also to consume food and water soiled and contaminated with the exceedingly infectious excretions of diseased hogs, was diseased with communicated swine plague, aggravated, maybe, by rough treatment and transportation by rail. Nay, more, it was even possible that the cattle (steers) condemned last winter in England as affected with pleuro-pneumonia, and alleged to be American, and even Western cattle, have either not come from the West, or from any of the Western States, in which contagious pleuro-pneumonia has ever been known to exist, or have not been diseased with contagious bovine pleuro-pneumonia, but only with communicated swine plague. On a great many farms in nearly all the Western States, the steers and hogs to be fattened for the market are frequently fed in one and the same feed-lot, and eat the same food and drink of the same water. It is therefore possible that swine plague, since it prevails almost everywhere in the whole stock-producing West, has been communicated in a few instances to steers; that those steers affected with only a very mild attack, too mild to be noticed, passed through the stock-yards in the West and at the sea-coast as unsuspected and healthy animals, and that the originally mild form of communicated swine plague became sufficiently aggravated by transportation, exposure, hardship, and confinement on the Atlantic steamer, to be readily mistaken for bovine lung-plague or contagious pleuro-pneumonia by the time the cattle arrived in England.

6. SWINE PLAGUE IN OTHER ANIMALS.

Professor Law succeeded in communicating swine plague to sheep and rabbits, and Professor Klein successfully inoculated rats, and so there is no doubt that those animals can contract the disease and become the means of its spreading. It may therefore be almost superfluous to mention that I have seen, while acting as inspector of cattle in the Union Stock Yard, several rats evidently diseased with swine plague. Professor Law's experiment in inoculating a dog has not been as successful as he desired, and there is no doubt that dogs possess comparatively little susceptibility, but they are, notwithstanding, able to contract the disease, as will be seen from the following: Mr. David Moore, a farmer residing two miles north of Champaign, is known to be a reliable man and a close observer of all the symptoms of swine plague in its various phases. Last year he lost nearly every hog he had on his place, and this spring he lost fourteen pigs. Late in the fall, so Mr. Moore informed me, his dog, a pointer, feasted on the unburied carcasses of hogs that had died of swine plague. In less than two weeks the dog was taken sick and showed symptoms identical, Mr. Moore says, with those exhibited by his diseased hogs. In about two weeks the dog was emaciated to a mere skeleton. It was over four years old, and Mr. Moore is positive that the disease was communicated swine plague and not common dog distemper, a disease which, by the way, was not prevailing in the neighborhood, and which very seldom attacks dogs over four years old. Of course this was not a case witnessed by myself, but I considered it worth relating, because I know Mr. Moore and cannot doubt his veracity.

7. THE CONTAGIOUS OR INFECTIOUS PRINCIPLE.—ITS SPREADING, ITS PROPAGATION, AND ITS VITALITY.

That the *bacilli suis* and their germs constitute the contagious or the infectious principle and the true cause of the disease has been confirmed not only by the result of my experiments with pigs Nos. 1 and 2, but also by numerous clinical observations. 1. None of the inoculations made since August 1 produced any local reaction except the second inoculation of heifer No. 2, which was followed by a very slight local reaction, consisting in a scarcely perceptible local swelling, easily accounted for by the manner in which the operation was performed. The point of the hypodermic syringe used was very weak and rather dull, and an opening through the skin had to be made with a knife, which caused a wound sufficient to produce such a slight swelling. In heifer No. 1, inoculated on the same day, and with double the amount of the same material, but by means of another hypodermic syringe with a point strong and sharp enough to penetrate the skin, no swelling whatever appeared. If the infectious principle consisted in something of the nature of a virus, or in something that possesses chemical properties, or does not need to propagate and to multiply before it can act, a local reaction would have taken place.

On the other hand, if an animal infected with swine plague receives a wound or an external lesion sufficient to cause congestion and inflammation, the morbid process is almost sure to localize in the congested or inflamed parts. Further, if the infectious principle is introduced into a wound or a lesion with inflamed, swelled, or congested borders—for instance, in a wound caused by ringing or by castration, &c.—the morbid process is sure to develop in the inflamed or congested borders of that

wound. All this is easily accounted for if the *bacilli* and their germs constitute the infectious principle, and if the mode and manner in which they obstruct and clog the capillary vessels is taken into consideration; but it is utterly irreconcilable with the non-appearance of any local reaction after an inoculation by means of a wound too slight to cause congestion if the infectious principle possesses the nature of a virus or of a chemical agency.

2. Swine plague, until the last days of December, or until the ground becomes covered with snow and the weather exceeding cold, was spreading from farm to farm and from place to place, but as soon as the temperature commenced to remain below the freezing point, at noon as well as at night, it at once ceased to spread from one farm or locality to another. At the same time, however, it was also observed that the very cold weather of the last days of December and of the first days of January—at seven o'clock in the morning of the 2d day of January the thermometer indicated at Gap Grove, Lee County, Illinois, a temperature of 28° below zero, and at the same hour on the day following a temperature of 24°—did not materially interfere with the spreading of swine plague from one animal to another in all pens and hog-lots in which the disease had previously made its appearance, and in which the way of feeding and watering the animals was such as to allow a contamination of the food and of the water for drinking with the excrements or other excretions of the diseased hogs, or in which the hogs and pigs, still healthy, had open wounds, sores, or scratches, and had to sleep together with the diseased hogs in the same sleeping place and on the same litter—old straw and manure, for instance. Afterwards, when milder weather had set in, the spreading from one place to another very slowly commenced again.

Now, if the *bacilli* and their germs do not constitute the infectious principle and the cause of the disease; if, on the contrary, the latter consist in some mysterious poison, or an invisible chemical fluidum, the facts and observations just related cannot be explained, because it must be supposed that the low temperature prevailing at the end of the old and the beginning of the new year, would have affected the infectious agency either not at all, or just the same within as without the hog-lot, and, at any rate, would not have prevented the spreading of the plague except by destroying the infectious principle. The latter, however, is not easily destroyed by frost, but only caused to become dormant till the temperature rises again, otherwise the exceedingly cold weather and continuous frost of last winter would have been sufficient to extinguish the disease; and the new outbreaks, or the renewed spreading, which took place when the weather became warmer, not only in one locality but in a great many, would not have been possible. All the facts and observations, however, will become perfectly harmonious, and be fully explained, if the means by which the disease is produced and communicated consists of something corporeal, endowed with vitality and means of propagation; in other words, if the *bacilli* and their germs constitute the infectious principle and the cause of morbid process, as will become more evident by the following results of my investigation:

Last summer and fall it was found that the *bacilli* and their germs, present in immense numbers in the excrements, urine, and all other excretions of the animals diseased with swine plague, were carried upward into the air by the evaporation of the fluid parts or watery constituents of those excretions, and came down again with the dew, the rain, and other precipitates of atmospheric moisture, and were deposited on the surface of everything wetted by the dew or the rain, on the grass

and on other food-plants of field and pasture, and in that way were conveyed from one place to another. Such a rising in the air, and such a conveyance of the bacillus germs from one place or locality to another, cannot be accomplished at all, or only to a very limited extent, while everything is frozen or covered with snow, because in that case all the moisture and watery parts, which otherwise might have evaporated, are locked up by frost—have become solid.

3. It was further observed that swine plague spread the most rapidly, and was the most malignant, among herds in which the animals had external wounds, sores, or lesions, caused by recent ringing, castration, &c., and in all those swine-yards or hog-lots in which an old straw-stack served as shelter and sleeping place. wounds, sores, and scratches constitute a port or entrée for the disease-producing germs, and partly rotten and constantly damp old straw-stacks not only catch the organic particles, such as the *bacilli* and their germs, that may be floating in the air, but also shelter and protect them against destructive influences, and favor and promote their development, propagation, and dissemination, first by being warmer, in the winter at least, than the surrounding atmosphere, and secondly, by absorbing and causing to evaporate, in consequence of their porous condition, a great deal of moisture. Clinical observations have convinced me that an old straw-stack may preserve the infectious principle for several months. The above facts, too, if looked upon in a proper light, will go far to show that the infectious principle must be something endowed with vitality and means of propagation.

4. When resuming my investigation in May, I went again to Champaign, Champaign County, Illinois, because I had been informed of the existence of swine-plague in the immediate vicinity of that place. Arriving there I found my information to be correct, but found also that the disease, which had never entirely ceased to exist in that county since July a year ago (1878), was spreading very slowly, and made a temporary stop, or ceased to spread immediately after each heavy or pouring rain, and during the spring most rain-storms in the West are of this character. I found, further, that even its propagation within the herd became visibly slower or stopped altogether for several days after each violent or pouring rain in all such herds as were kept in a pasture or a hog-lot sufficiently drained to enable the water to flow off; but the spreading was not visibly interrupted in such herds as were kept in a timber-lot or in a pen under roof. So I have necessarily come to the conclusion that each pouring rain brought down the *bacilli* and bacillus germs floating in the air and washed them away at once, not only from the grass and herbage, but also from the surface of the ground. In timber lots, however, it was different; there the force of the rain was broken by the trees and the usually rank vegetation beneath, and there the water does not run off as fast as from a pasture, or from a bare hog lot. Besides, the drainage in the timber, as far as Illinois is concerned at least, is usually very indifferent.

As to the nature of the infectious principle there can be, in my opinion, no more doubt; and in regard to its spreading my recent observations have corroborated the conclusions arrived at last summer and fall. To sum up, swine plague spreads and is communicated to healthy animals: first, by an introduction of *bacilli* and bacillus germs into the digestive canal with the food and water for drinking; and, second, through wounds, sores, and scratches, or by direct inoculation. Whether they can also enter (and communicate the disease) through the whole skin, and through the whole respiratory mucous membrane, free from any

lesions whatever, is doubtful, and a question I have not been able to decide. According to what I have been able to see and to observe it is not probable, still it may be possible.

The *bacilli* and their germs can be conveyed from one place to another not only in and with the morbid products of the disease, and the tissues, fluids, and excretions of the diseased and dead animals by themselves, or by adhering to and contaminating other inanimate things, fluid or solid, but also independent of any other vehicle through the air at a distance of a mile, if circumstances are favorable, and in the water of running streams. They are even able to propagate in water, especially if it is not free from organic admixtures. An incident happened while I was, last winter, at Gap Grove, which is worth relating. On January 27, in the afternoon, I filtered some pulmonal exudation of a pig that had died of swine plague through several papers for the purpose of freeing it from the bacillus germs which it contained. The filtering was done on a small table in a corner of the room, and the apparatus was left standing on that table with the wet papers (4) in the funnel after the filtrate had been removed. In the evening the latter was examined under the microscope on another table in the opposite part of the room, and as my two highest objectives are immersion lenses, I had to use water, and had a tumblerful of clean well-water on my table, just drawn from a deep well. When through with my work, instead of pouring the water out, I placed the tumbler on another table about four feet distant from the filtering apparatus. Next morning I went to Chicago to return on the 30th. In Chicago I procured a new objective, also an immersion lens, and about the first thing I did after my return was to try that objective. Finding everything undisturbed in my room, and the tumbler with water exactly where I placed it, and not intending to examine but a test object, I did not go for fresh water, but used a drop of the water in the tumbler for the immersion. While adjusting the focus, I discovered that the water, which I knew had been absolutely free from organic bodies, was swarming with *bacilli* and bacillus germs of the same kind as those in the pulmonal exudation. I made then a thorough examination of the water not only with the new, but also with the old objectives, and found that every drop taken from above (the surface) contained myriads of *bacilli*, some of them moving very lively, while in a drop taken from near the bottom but comparatively few could be found. The filtering paper left in the funnel wet and full of bacillus germs and *bacilli* was perfectly dry. All the moisture had evaporated; the aqueous vapors had carried the bacillus germs with them into the air, and many of them undoubtedly had been deposited in the tumbler and in the water it contained, and had there developed and propagated. Another solution is not well possible. The next day the water was examined once more, and it was found that the number of the *bacilli* had become still greater. Soon after I dropped a few grains of thymol into the water, and two hours later every bacillus had been destroyed—at least none could be found.

The peculiarities and the "freaks" in the spreading of swine plague are best illustrated by a brief history of the disease and its progress on Henry Miller's farm, one mile north of Prairieville. Late in the fall of 1877, when no swine plague was existing within fifteen or twenty miles of his place, Mr. Miller bought twenty-six shoats in a part of Whiteside County in which swine plague at that time was prevailing and had been prevailing very extensively. Those shoats themselves *appeared* to be healthy, but had been exposed, as was learned afterwards, to the influence of the infectious principle, and it is possible and even probable that

one or more of them suffered from a mild attack: at any rate, those shoats introduced the germs of the disease into Mr. Miller's herd, because soon after their coming swine plague made its appearance in a (so-called) sporadic form. Whether one of the new shoats or an animal belonging to the old herd was the first victim Mr. Miller does not remember. A few words concerning Mr. Miller's farm and swine yard will be necessary. His farm consists of 320 acres of undulating prairie, divided by Sugar Creek into two parts, and his swine yard is large, slopes a little towards the creek, and contains several hog sheds and cow sheds, which are covered with old straw. The losses during the winter, or until spring, were not very severe, only now and then a few animals died, but in the spring, after the sows had farrowed, Mr. Miller lost a great many or most of his young pigs, and only a few of his older hogs, something not very strange if it is taken into consideration that the season, a cold winter, had not been favorable to a rapid and vigorous propagation of the infectious principle, and that young pigs not only possess the greatest susceptibility and succumb to the slightest attack, but also have for obvious reasons far more chances to become infected than older hogs. As soon, however, as the heavy spring rains set in the disease ceased to make much progress—at any rate, from May till August but few new cases and few deaths occurred. The pouring rains, it seems, washed away most of the disease germs into the creek, and the current carried them off. But in the early part of August, as soon as the season for heavy dews arrived, the disease almost at once commenced to spread very rapidly, and the swine died very fast. Mr. Miller's whole herd consisted of 240 head, and 237 died; only three survived or remained exempted. At that time no other case of swine plague existed in the whole neighborhood, and, according to the best information I could obtain, there was none within twenty miles. Soon, however, the disease commenced to spread from Mr. Miller's herd to those of his neighbors, first to the herd of his neighbor towards the north—the prevailing wind was from the south—then all around, and finally over the whole township and beyond. In November, 1878, Mr. Miller, when he had only three hogs left, bought again thirty-two head. These, too, very soon became infected, and commenced to die at the rate of one, two, and three a day. On December 29, fourteen had died, two died that day, and most of the others were sick and died afterwards. The fluctuations in the progress of the plague in Mr. Miller's herd may seem to be strange at a first view, but if all circumstances are taken into consideration, they become very interesting, and contribute very much to a better understanding of the nature of the disease.

Another case, which shows how easily swine plague may be communicated, may also be worth relating. Pat Murphy lives 1½ miles south of Gap Grove. Up to January 2, he had lost five hogs out of a herd of ten head; seven had been sick, but two had recovered. Mr. Murphy's place, although on a public road, which, however is but very little used, is rather secluded. He made the following statement, which scarcely needs any comment: About ten days or two weeks before his hogs showed any symptoms of disease, a wagon loaded with several carcasses of dead hogs on the way to a rendering establishment passed by his hog lot adjoining the road on the east, and separated from it only by a fence. Whether Mr. Murphy's hogs became infected by the passing of the wagon with the dead hogs—the wind was from the west and blew the emanations of the latter into the hog lot—or not, is a question difficult to decide. One thing, however, is certain, Mr. Murphy's hogs were the first ones that were taken sick in his immediate neighborhood, and

those of his next neighbor south, Mr. Hadeler's, became affected next. Mr. Hadeler lost one hundred head, and saved nine. His hogs affected those of Mr. Lawrence, who lives a little further south, close to the northern bank of Rock River. From Mr. Lawrence's farm the disease traveled west half a mile, and invaded Mr. Muller's herd. I was at his place on January 3, soon after the plague had made its appearance. Mr. Muller had his herd divided, and kept one part in one yard, and the other in an adjoining one separated from the former by a board fence. The disease was prevailing only in one yard, in the one toward the east. Five animals had died. Owing, probably, to the severe cold, and to the 15 or 18 inches of snow covering the ground and preventing evaporation, the plague remained confined to the eastern yard, and the animals in the western yard escaped.

I could cite many more cases illustrating the peculiarities of swine plague in its spreading or propagation, but those given, I think, may suffice. The mortality, all other conditions being equal, is always greater the larger the herd and the younger the animals.

In my first report I stated that the vitality of the *bacilli* and their germs is not very great, except where circumstances and surroundings are favorable. This opinion has been confirmed by further observations and experiments. In all animal substances the *bacilli* and their germs are destroyed, or at least disappear, as soon as putrefaction sets in; or, to be more definite, they begin to disappear in animal fluids and other animal substances as soon as the putrefaction bacteria make their appearance (see drawings), and cannot be found after the putrefaction bacteria have become numerous. On the other hand, if contained in a fluid that does not undergo putrefaction, or in which *bacterium termo* does not appear, the vitality of the *bacillus suis* is a great one. On the 27th of January last I put some filtrated pulmonal exudation (of a pig that died of swine plague) swarming with bacillus germs, but consisting of about one-half of water, which had been added by moistening the filtering papers in a 1-ounce vial with a tight-fitting glass stopper, and left it untouched until the 12th of April, when I examined it again, and found numerous *bacilli suis*, some of them moving very lively. The vial and its contents, meanwhile, had been exposed to a variety of temperature, ranging from the freezing point to nearly 100° F.

On June 10 I took two perfectly clean 4-ounce vials, and put in each three ounces of clean well-water in which no bacteria nor any other living thing could be found. In one vial, marked No. 1, I put half a drop of the fresh pulmonal exudation of a pig that had died of swine plague (Mr. Coffee's), and in the other vial I put one drop of the same pulmonal exudation and three drops of pure carbolic acid. Both vials were immediately closed with new corks, and sealed perfectly air-tight with asphaltum. Both vials were opened and their contents examined on July 24. The water in vial No. 2 was examined first, and contained a few motionless *bacilli* and some clusters of bacillus germs. The water in vial No. 1, which was examined next, contained a few moving and several motionless *bacilli*, numerous germs, single and double, several clusters, and a few (two or three on a slide) well-preserved blood-corpuscles.

As has been stated in the chapter on "Morbid Changes" (cases 7 and 8), I had an opportunity on January 22 to make a *post mortem* examination of two hogs which had been down with swine plague in the early part of November, and had recovered two months ago, and had thus a chance to see to what extent the morbid changes had been reduced by melting and absorption of the morbid products, and retrogressive pro-

cesses in general. On examining the lungs of one of those hogs (No. 8) microscopically, it was found that the serum and melted exudation, which could be pressed out of the hepatized portions, still contained some *bacilli* and bacillus germs, but no clusters (see drawing), which leads me to suppose that under favorable circumstances an animal that has recovered from swine plague may, after two months, be able to communicate the disease to healthy pigs. Unfortunately just then no healthy pig, not already designed for another purpose, was available; otherwise, I would have put that question to a test. If swine plague can be communicated by an animal two months after recovery—of bovine pleuro-pneumonia it is well known that it can be spread by cattle that have been convalescent for over two months—many, otherwise mysterious, outbreaks of swine-plague may be explained.

8. THE MORBID PROCESS.

Since my first report was written (December 1) numerous microscopic examinations of morbid tissues, morbid products, blood, &c., have been made, and *bacilli suis* in different stages of development have been found in every case (see drawings), but as to the manner in which the morbid changes are produced nothing new has been discovered; consequently I have nothing to add to what has been stated in my first report, except that all my observations tend to show that most, if not all, of the morbid changes—at any rate those in the lungs and in the skin—are brought about by the *bacillus* clusters clogging and obstructing the capillary vessels.

9. PERIOD OF INCUBATION OR STAGE OF COLONIZATION.

Its duration seems to depend somewhat upon the number of the *bacilli* and bacillus germs introduced at once into the system, and also upon the stage of development of those disease-producing germs at the time of introduction. At any rate, the average time which elapses after an inoculation before plain symptoms of the plague make their appearance, varies somewhat according to the quantity of infectious material inoculated, and probably also to the resistibility of the animal organism. A large quantity inoculated at once may cause a temporary reaction on the second day, while a very small quantity, say one-sixth or one-eighth of a drop, of pulmonal exudation does not produce any visible effect in less than five to seven days.

10. MEASURES OF PREVENTION.

The cheapest and best way to get rid of swine plague is to stamp it out, notwithstanding the disease has been allowed to exist a whole quarter of a century, and has been permitted to spread over twenty-nine States and Territories. A radical extermination is the only thing that will be effective, unless it can be proved that a spontaneous development is taking place, or can take place, within the borders of the United States. Fortunately, the low temperature of the winters in our principal pork-producing States facilitates a stamping out, if undertaken at the proper time—in the winter and in the spring—because a low temperature (frost), and especially snow, interrupt very essentially the propagation of the disease-germs and the spreading of the disease, and, although not absolutely destroying or killing the *bacilli* and their germs, cause a great many of them to perish or to be in a dormant state for some time. Be-

sides that, the number of hogs and pigs in existence from the first of January to the first of April is a comparatively small one, because most of the hogs have been shipped and butchered, and the young pigs have not been born. But the measures of extermination or stamping out must be thorough. Anything undecided, doubting, hesitating, or wavering and favoring, will be of no avail, but will only tend to prolong the existence of the plague and increase the cost. Still, as long as we have no stringent legislation that applies to the whole country and will be obeyed and be enforced everywhere, no results can be expected.

As to local measures of prevention, in every case they must consist in a thorough destruction of the infectious principle, or, what is practically the same, in promptly removing the animals to be protected out of the reach or influence of the *bacilli* and their germs. Whether the latter are destroyed by physical agencies or by chemical means, so-called disinfectants, is immaterial. What I have said in my first report in regard to keeping not more than two or three animals together in movable pens constitutes probably the best means of protection, as far as single herds are concerned. But I admit that such a separation is sometimes impracticable, or may be considered as too expensive or too troublesome by the owner, and it may also happen that an infection has taken place before the necessary preparations have been made. In such a case a strict and, if necessary, repeated separation of the healthy animals from the diseased ones, not only as to pens and yards, but also as to attendance, and a thorough cleaning and disinfection of the infected premises, constitute the least that may be expected to afford any protection. That the food and water given to the healthy animals must be clean and uncontaminated with the infectious principle, and that dead animals must be buried or be cremated at once, may not be necessary to mention again. As a disinfectant, I would recommend carbolic acid as one of the cheapest and most convenient, notwithstanding that some others may be more effective.

A few cases will illustrate what is necessary and what may be expected of simple and local means of prevention, but it must be kept in mind that in the summer and in the fall, when everything favors a rapid development, propagation, and dissemination of the disease germs, much more circumspection and thoroughness is required than in the winter, when a low temperature and a limited evaporation of moisture retard the propagation and dissemination of the *bacilli* and their germs, or in the spring, when heavy rains may wash the latter away. In winter and spring strict separation and good care are usually sufficient to prevent a serious spreading of the disease; in the summer and fall the most scrupulous care will be required in guarding against an introduction of the infectious principle and in destroying it wherever it may happen to exist, provided it is contained in, or adheres to, something on or in which it can be destroyed, either with or without its vehicle.

Mr. H. Fisher lives one and a half miles north of Prairieville, and half a mile north of H. Miller. He makes swine breeding his principal business, and his accommodations for his hogs are nearly perfect. His swine-yard is divided into several divisions, and each division again into several separate apartments, composed each of a spacious yard and a good and well-ventilated pen with a wooden roof. Each separate yard, finally, contains a good trough for water and a wooden platform for food. Consequently, his herd, when occupying the swine-yard, is practically divided into many small herds, perfectly independent of each other. The food (corn) is thrown on the platforms, and the water for drinking is pumped from a well by a windmill, and conducted

through pipes and hose into the numerous troughs. In the early part of August, 1878, Mr. Fisher sold two hundred hogs and pigs at auction, which sale reduced his herd to seventy-eight head, the number of which it consisted when swine plague invaded his place. When the first case occurred most of the seventy-eight animals were running out in the pasture, and there, it must be supposed, most of the animals that were taken sick became infected; at least but a few new cases of disease occurred after the hogs were kept up again in their yards and pens. Although Mr. Fisher did not use any medicines whatever, his total loss amounted to thirty-three head out of seventy-eight; forty-five head remained exempted (most of them) or recovered (a few), while his nearest neighbor, Mr. Miller, lost two hundred and thirty-seven animals out of two hundred and forty. Fisher's sanitary arrangements were good—nearly perfect—and his herd was divided into small lots, none of them numbering more than five or six animals, while Mr. Miller's hogs and shoats were all in one herd. Comment will not be necessary.

Mr. F. Brauer, at Gap Grove, had, in the early part of January, one hundred and forty hogs and shoats in two yards, separated by a fence—sixty barrows in one yard and about eighty sows in the other. Mr. Brauer's nearest neighbors west and east live only a little more than a quarter of a mile from his house; the neighbors northwest and southeast are farther away, and due north and south no house is nearer than a mile. Swine plague prevailed or had been prevailing between September and January, on every farm adjoining Mr. Brauer's. On his place the two swine-yards, which are side by side and destitute of any old straw stack and of half-rotten piles of old straw or hay, are on high ground sloping toward the east, and are protected toward the west by barns, stables, and sheds. The food consists of corn from a corn-crib, which constitutes a part of the northern fence or inclosure of the yard occupied by the barrows, and the water for drinking is pumped by a windmill from a deep well, and conducted through iron pipes into the troughs. On the morning of January 6, one of the barrows was found dead, and presented at the *post mortem* examination, which was made immediately, just such morbid changes as are characteristic of swine plague. The infectious principle, it is supposed, had been introduced by some horses which were running at large, jumping fences, and in the habit of visiting all the swine-yards and corn-cribs in the whole neighborhood in search of corn. Mr. Brauer, to avoid greater losses after that one barrow had died, sold and shipped immediately forty-six of his barrows, so that only thirteen animals remained in the northern yard. The latter was cleaned at once, and disinfected by a liberal sprinkling with diluted carbolic acid once a day, on January 6, 7, and 8. The thirteen barrows in the northern yard and the eighty sows in the southern yard have remained healthy, and no new cases have occurred.

Mr. Swigart, in Palmyra Township, kept his hogs and cattle (steers to be fattened) in a yard which contained two old straw stacks, and was well littered with half-rotten straw and hay. When I visited his place the first time, on the 14th of January, fourteen hogs had died, several were sick, and some apparently yet healthy. The first cases had occurred only a week or two previous. The diseased hogs were all bleeding from the nose. I advised Mr. Swigart to immediately separate the apparently healthy animals from the sick ones by removing them to a non-infected place, and give to each animal twice a day about ten drops of carbolic acid in the water for drinking. This advice was

complied with, and none of the animals removed from the infected yard became diseased.

Mr. Dillon, one and three-quarters miles north of Champagin, had lost two pigs diseased with swine plague on June 10, on which day he removed his small herd of fourteen head to a non-infected locality. No other deaths had occurred when I left Champaign on July 5.

II. TREATMENT.

In regard to treatment no new discoveries have been made, but my views, expressed in my first report, have been very much confirmed. Good care, clean and uncontaminated food and water, strict separation from diseased animals, and scrupulous cleanliness, so as to prevent the animals from satisfying their vitiated appetite for excrements and urine, and from introducing thereby into their organisms more and more of the infectious principle, go a good ways in preventing an attack of swine plague from becoming very malignant and in facilitating a recovery. Medicines seem to be of little avail—at least everything that has been tried without any prejudice has failed to produce visible good results. Patent nostrums and secret medicines have done more harm than good. Mr. Hoyt, of Mendota, informed me that one of his neighbors, who had extensively invested in "Eureka Specific," had lost in proportion more hogs than anybody else in the neighborhood that had not used any medicines whatever.

If it is intended to stamp out the disease, any treatment of the sick animals should be prohibited by law, unless a sufficient bond is given to cover any possible damage that may result, because the treatment of such a contagious or infectious disease always involves great danger in so far as it tends to preserve the infectious principle and facilitates the spreading of the plague. To destroy the cause, or, what is the same, the infectious or contagious elements, wherever and in whatever shape and form or substance it may exist, is the only rational way of dealing with such diseases. Swine plague should and ought to be treated the same as rinderpest or cattle plague, pleuro-pneumonia or lung plague, glanders, and farcy. The most thorough and decisive measures are in the end the cheapest.

Respectfully submitted.

H. J. DETMERS, *V. S.*

CHICAGO, ILL., *July* 25, 1879.

SUPPLEMENTAL REPORT.

SIR: Immediately after you re-employed me, on the 8th of October last, and instructed me to resume the investigation of swine plague, I took the necessary steps to obtain reliable information as to where the disease might be prevailing to such an extent as to afford sufficient material for my purpose, and soon learned that the disease existed in several counties in Illinois and Wisconsin, within a radius of two hundred miles from Chicago. For several reasons I chose as a suitable locality for my investigation the county of Henderson, in the western part of the State of Illinois, and on the eastern bank of the Mississippi River, notwithstanding sufficient material might have been found much nearer my home—for instance, in the county of La Salle. Every county and every place in this State, in which swine plague is or has been pre

vailing, contains one or more rendering-tanks, and men who speculate upon the credulity of the farmer when in distress, and try to sell him a "sure cure for hog cholera" at an enormous price. I know a large number of farmers who paid from $30 to $60 for a worthless prescription, and others who paid as much as $100 for worthless medicines, composed of substances that can be bought in the market for about $5. These persons—the tank-men and the "sure-cure men"—find it in their interest to keep the farmer ignorant, to prejudice his mind, and to prevent, if possible, a thorough investigation. So it happens that many farmers deny the existence of the disease if approached by a stranger, or are asked questions concerning the health of their hogs. A great many farmers have also another motive for keeping the existence of swine plague a secret. They sell their hogs and pigs for whatever they can get, and ship them to Chicago as soon as the well-known disease makes its appearance. In Chicago, however, the city board of health is at present more vigilant than formerly, and condemns a few diseased hogs almost every day. This has had a good effect, in so far as the buyers have become a little shyer and more careful, and refuse to buy every diseased animal that is offered; they have also commenced to inquire where the diseased hogs are shipped from, and where swine plague is existing. The farmers and country dealers who send them are, therefore, interested in denying and concealing the existence of the disease. Some farmers, to my certain knowledge, have even stooped so low as to sell and ship their diseased hogs, not in their own name, but in that of some irresponsible person, and don't like to hear swine plague mentioned. Consequently, any investigation of the disease is exceedingly difficult and almost impossible, unless the investigator is either personally known or introduced by a citizen who commands the confidence of his community. Not being personally acquainted in any of those counties in which the disease, according to information received, was prevailing to an extent sufficient for my purpose, I chose a place where I could procure such an introduction. I happened to be acquainted with one of the most prominent and influential citizens of Henderson county, Mr. James Peterson, at Oquawka, who, on corresponding with him, invited me to his place, stated that he would take great interest in my investigation, and promised to go with me through the county and introduce me to the farmers whose herds had become affected. His invitation, of course, was accepted, and as his promise has been fully redeemed, his kind offer has considerably facilitated my work. One other reason induced me to select Henderson County. I considered it of some importance to observe the disease in different localities, different at least as to soil and drainage. In most of the places in which I carried on my former investigations, the soil is entirely different from that of Henderson County, which is very sandy, especially along the Mississippi River. Champaign County, for instance, is almost level, and the soil is a rich black loam; Lee County, or at least that portion of it in which I investigated last winter, is somewhat similar, only more undulating and better drained; Stevenson County, in the neighborhood of Freeport, is still more undulating, and Fulton County is again somewhat similar to Champaign.

In my former investigations of swine plague, I made it my principal object to ascertain the nature and the workings of the morbid process, and the real cause or causes of the disease and its spreading. In resuming my investigation this fall—in October last—I thought it would best serve the purpose to make it a special object to obtain or to search for such results as are of an immediate and practical value to the farmer,

pork-producer, and swine-breeder. In other words, to ascertain as far possible the means or media by which swine plague is actually and principally spread from place to place, from herd to herd, and to learn by observation and experiment what may be done by the individual farmer and swine-breeder to protect his herd, and to effectually prevent the spreading of the plague, or to stop its progress. I made it also an object to decide, by means of experiment and observation, whether the morbid process, once developed, can be arrested by a simple medical treatment —such a one as can be applied by the farmer—or not. Before I state the results of my present investigation, it may be in order to first make a few general statements, and to give the facts and observations upon which those conclusions have been based, so as to enable the reader to judge without bias, and to form an opinion of his own. I may also be allowed to state that to obtain these facts and make these observations I have visited twenty-five different herds of swine in different parts of Henderson County, and several of them from four to eight times; have made fifteen *post mortem* examinations; subjected to a special treatment six different herds, namely, those of Messrs. Kennedy, Gilchrist, Rice, Morris, Beaty, and Graham; and have experimented on three healthy pigs, specially procured for that purpose. It may further be stated that the disease is, or was, prevailing this fall and winter, or from October 13 till the present, in a much milder form in Henderson County, a few herds excepted, than it was last year at the corresponding season in the counties of Champaign, Stevenson, Fulton, and Lee. At any rate, the prevalence of the disease was not as general, its spreading was not as rapid, and the mortality was not as great as during the same months of last year in the counties named. The morbid process, too, in a majority of cases at least, was found to be limited almost entirely to the organs of the chest (lungs, pleuras, and heart), and to the lymphatic system; while last year serious morbid changes in the intestines, such as ulcerous tumors in the cæcum and colon, presented themselves in about 75 per cent. of all the cases examined, in addition to the morbid changes invariably found in the respiratory organs. This greater leniency of the disease must, of course, be taken into consideration in judging the results of the experiments, and the effect of the measures of prevention and of the medical treatment.

Still, notwithstanding this greater leniency and the frequent absence of conspicuous morbid changes in the intestines, numerous examinations of living animals, fifteen *post mortem* examinations, and repeated microscopic investigations have convinced me that the disease prevailing this fall and winter among the swine in Henderson County is exactly the same swine plague found last year in the counties of Champaign, Stevenson, Fulton, and Lee, only this year's epizootic is milder, and the digestive organs, but especially the colon and cæcum, are less frequently affected, which may account for the decreased malignancy or fewer deaths and the slower spreading, because the infectious principle is always the most concentrated, or, what is the same, the disease-producing germs, the Schizomycetes or bacillus germs, as I have called them before (perhaps, erroneously, *cf.* below), are always the most numerous in the excrements of animals in which the morbid process is prominently developed in the intestinal canal. The duration of the disease in the individual animals, or the time which elapses from the appearance of the first symptoms till a termination, either in death or convalescence, is reached, seems also to average a longer time this winter—in Henderson County at least—than last year at the other places named. Several circumstances, undoubtedly, have combined to produce this result. Last

winter, particularly in the latter part of December (1878) and in the month of January (1879), the temperature of the atmosphere was very low; it snowed considerably; the snow became very deep and covered the ground for a long time; consequently, everything on the surface of the ground remained unchanged and unmoved, and the evaporation of moisture was very limited. The disease-producing germs, or the Schizomycetes, which constitute the cause and infectious principle of swine plague, although not immediately and necessarily destroyed by frost and snow—recent developments have shown that these germs may retain their vitality for a considerable length of time even if imbedded in ice—were prevented from rising into the air, and thus from being carried by winds from one place to another, neither could the same be conveyed from one herd to another in streamlets and currents of water, because everything was frozen and covered with snow; consequently, these germs or Schizomycetes could not propagate; they were kept dormant or in a state of rest, and there can be no doubt that a great many, perhaps most of them, were thus prevented from finding their proper nidus and therefore perished. Consequently, in the latter part of the winter, 1879, but little disease was existing. The plague had almost died out everywhere. Toward spring, however, sporadic cases made their appearance, especially at the borders of timber lands and in swine yards and pastures which contained old straw stacks, or something of a similar nature calculated to give shelter and protection and the means of propagation (warmth and moisture) to the Schizomycetes or disease-producing germs. From such centers, at the close of last winter when snow and frost disappeared, the disease commenced slowly to spread, but in the spring nearly every week or ten days a pouring rain set in and probably washed away most of the germs or Schizomycetes which existed at places accessible to swine, or at which a chance was given to enter the organism of a hog or pig with the food or water for drinking. Be that as it may, one thing is certain, immediately after a heavy or pouring rain a perceptible stop or cessation could be observed in the spreading of the disease, while each time after the lapse of about a week a renewed spreading took place, to be interrupted only by the next heavy or pouring rain. Thus the plague made but little progress until the pouring rains became less frequent or ceased altogether, or till July and August, when a drier season set in, in which heavy dews took the place of heavy rains; but even then, in midsummer, swine plague failed to make as rapid progress as a year ago (1878), because the season very soon became too dry to be favorable to a rapid and extensive propagation and dissemination of the disease-producing elements. Further, during last fall and the larger part of the present winter, the season, with brief interruptions, has been very dry, at any rate in Henderson County; and it seems a dry season is not at all favorable to the propagation of swine plague, unless drainage is very poor and the soil is inclined to be wet. Careful observation has convinced me that continued dry weather on the one hand and pouring rains on the other have a decided tendency to reduce, and a common wet spell, brought about by repeated light rains—a few of about a week's duration were experienced—will invariably promote the spreading of the disease. If it is taken into consideration what has been ascertained in regard to the nature of the Schizomycetes, and the manner in which they are conveyed from herd to herd, and from animal to animal (*cf.* below), no explanation will be necessary.

Whether the circumstances just related have also diminished the intensity of the infectious principle or the vitality of the Schizomycetes

by not affording favorable conditions for development and propagation, or sufficiently frequent changes from within to without, and *vice versa*, of the animal organism, as seems to be the case, or whether they have only reduced the number of those microscopic parasites by causing a great many to perish, or denying them an opportunity to reach their proper nidus or place of development in the body of a hog, will be very difficult to decide, and is practically immaterial.

At first, it appeared that the disease was milder only in Henderson County, and I thought the sandy soil, the hilly or somewhat broken surface near the Mississippi River, and the, therefore, more perfect drainage might have something to do with it; but this probably is the case only to a very limited extent, because reliable people have assured me that the disease was last year (1878) just as malignant in Henderson County as in any other place. Still, the sandy soil, good drainage, &c., is probably not altogether without influence, especially if the season is inclined to be dry, for, even during the present winter (1879–'80), the disease proved to be more malignant in the eastern parts of the county, in the vicinity of Biggsville, where the soil is darker and heavier and the surface less broken than further toward the Mississippi.

One other circumstance may also have contributed somewhat in causing swine plague to be more lenient this year than a year ago. All contagious and infectious diseases, in order to affect an animal, seem to require in the latter a certain degree of predisposition; in other words, the disease-producing Schizomycetes, in order to be able to produce morbid changes, seem to require certain conditions which do not exist in the same degree in every animal, and which, to all appearances at least, may even be entirely absent in some few animals, or may become partially or fully exhausted, or completely destroyed under peculiar circumstances; for instance, by a previous attack. Further, it is well known that on the first appearance of almost every contagious or infectious disease those animals, as a rule, become affected first and succumb soonest which possess the greatest predisposition or offer the most favorable conditions for the development and the effectiveness of the infectious principle. Swine plague does not seem to make an exception. Wherever it prevailed very extensively a year ago, it may be presumed that the hogs and pigs which possessed a special predisposition, or offered very favorable conditions, and became exposed to the influence of the infectious principle, contracted the disease and have since died, and consequently are out of the way; that most, if not all, of the older hogs at present existing, especially as the disease prevailed last year almost everywhere, are animals with comparatively little predisposition; and that the pigs born since last spring and now living are mostly the offspring of sows which were not much predisposed, or did not offer very favorable conditions for the development of the disease. That such a difference as to predisposition must exist becomes patent by the fact that in nearly every affected herd, no matter how malignant the disease may prove to be, one or a few animals will either remain exempted altogether or will concontract the disease only in a very mild form, and recover. It receives also some additional confirmation by the fact that wherever swine plague makes its appearance for the first time it usually proves more malignant than at places at which it has been prevailing year after year, provided the quantity and intensity of the infectious principle are about the same. In Henderson County the disease has been an almost regular visitor for twenty-seven years, and in Southern Wisconsin it is a comparatively new disease. According to a letter received in December (1879) from a reliable person in Bloomington, Grant County, Wiscon-

sin, swine plague, notwithstanding a very small beginning—it was introduced by one diseased pig from Iowa—in November last caused very severe losses there.

FACTS AND OBSERVATIONS ILLUSTRATING THE MEANS BY WHICH SWINE PLAGUE IS SPREAD.

1. *Mr. Kennedy's herd, Rozetta, Henderson County, Illinois.*—I made my first visit to Mr. Kennedy's place on October 14, and found a few cases of swine plague. His hogs had been all right till within a few days. The disease had been introduced by three animals recently bought out of an infected herd.

2. *Mr. Forward's herd, near Sagetown.*—I was at Mr. Forward's place on October 20. He has no near neighbors. His farm is a very large one, somewhat isolated, and situated at the head of several ravines. Consequently several small streamlets, so abundant in Henderson County, have their source on the farm, and only one has its source above, and runs through it. The piece of ground used by Mr. Forward as a hog pasture is flanked on three sides by timber, and his herd of swine, thus somewhat protected by the lay of the land against an invasion of swine plague, remained exempted from that disease until last year. Three-quarters of a mile from Mr. Forward, situated at the head of a ravine, which, however, does not extend through the farm, is a rendering-tank, where dead hogs are rendered up into grease or lard-oil. At the tank the carcasses are cut up, pieces are frequently lying about, and those parts which do not contain any grease or which are not worth tanking, such as the lungs, intestines, &c., parts which usually constitute the principal seat of the morbid process, are thrown into the ravine, and are washed away by the water if the season is rather wet, or remain where they are thrown till it rains. Further down this ravine unites with another one, and these two united form a small creek, which empties into the Mississippi River. Every herd of swine that had access to that creek became affected, and nearly every animal died. According to Mr. Forward's statement, his herd of swine, about two hundred head, remained exempted from swine plague till last winter (1878–'79). One morning he found in his hog-lot the head of a dead hog, deposited there, he thinks, by a dog, which picked it up at the rendering-tank. When he found it his hogs were already feeding on it. Exactly six days later some of his hogs exhibited symptoms of swine plague, soon a great many became affected, and finally nearly every hog and pig of his herd died.

3. *Mr. Robert Hudson*, a storekeeper in Oquawka, made the following statement:

> I have a farm on the banks of Henderson River, and last year kept quite a herd of hogs. One morning I found lodged at my hog-lot, which joins the river, a dead hog, which had come down stream, and had probably been thrown in some distance above. My hogs discovered it earlier than I, and were feeding on the carcass when I came. Ten days later they commenced to die. My loss amounted to fully $1,500.

4. *Mr. W. H. Lord*, who lives in Warren County, on the county line between Warren and Henderson, stated to me on October 21 that he had had no disease among his hogs since 1862 except two years ago, when swine plague was communicated to his herd by a drove of hogs, which came from an infected herd, and was permitted, in his absence, to stay over night in his hog-lot. That his swine (his herd is not a large one, and averages only about fifty or sixty head) remained exempt from swine-plague every year except two years ago, notwithstanding the disease prevailed in his neighborhood annually, is accounted for by Mr.

Lord as follows: His hog-lot is on high, dry, and bare ground; contains neither straw-stacks, rubbish, half-rotten manure, nor pools of stagnant water, and is kept as clean as practicable. Further, his hogs and pigs are always confined to this yard, and are never allowed to run at large; they receive their water for drinking regularly from a good well, and their food from a corn-crib, situated in the northeast corner of the hog-lot. (I inspected his place afterwards, and found things exactly as stated.)

5. *Messrs. Moir and Peterson* several years ago were engaged in the distillery business, and fed about 2,000 hogs. Their hog-pen, which is still standing, but has not been used for several years, is three hundred feet long, and situated close to the bank of the Mississippi. Swine plague broke out among their hogs and caused a heavy loss. Several times it subsided, or was temporarily stopped by a liberal use of chloride of lime, employed not only as a disinfectant and used externally, but also fed to the hogs by mixing considerable quantities of it with the slop. As soon, however, as the use of the chloride of lime was discontinued, the disease invariably, in about a week, broke out anew, and was just as malignant as ever. The experiment was repeated several times with the same result. Finally Messrs. Moir and Peterson conceived the idea of dividing the long pen into a dozen separate apartments by putting in partitions, but the feeding-trough, extending through the whole length of the building, from one end to the other, and sloping gently toward the west, was not divided; the slop, as before, was let in the upper, eastern end, and ran down through the whole length of the trough to the lower, western end, where, finally, the refuse was emptied into the Mississippi. After this but very few cases of sickness occurred among the hogs in the upper or eastern divisions, which received the slop clean as it came from the distillery, while in the lower or western divisions, at which the slop arrived after it had passed through the upper and middle parts of the trough, and had been soiled and contaminated by all the hogs in the apartments above, nearly every animal became affected and died. In the lowest divisions not one escaped, while in the upper ones no deaths occurred. It is, however, but justice to state that Messrs. Moir and Peterson, finding much more sickness in the lower than in the upper part of the building, soon commenced to use the lowest division as a kind of hospital, and used it almost exclusively for sick hogs taken out of the upper and middle divisions, which, of course, accounts to some extent for the slight mortality in the upper and middle divisions of the building, and explains why every animal died in the lowest division, but it does not account for the numerous deaths in the second, third, and fourth lowest divisions.

6. *Mr. Sam. Whiteman*, near Rozetta, had swine plague in his herd a year ago last winter, and disposed of every hog and pig he could find on the place. He intended to commence anew, and bought twenty head of healthy shoats. After receiving them one dead pig, belonging to his old herd, was found stiff and frozen in a fence-corner, where it had died. It was immediately buried three feet deep, but in frozen ground, and there the carcass remained frozen till the latter part of winter, when it was found unburied and consumed by the twenty healthy shoats. Ten days later the shoats commenced to die of swine plague.

7. *Captain William Morris*, in Bald Bluff Township, near the county line between Henderson and Warren, gave me the following information: Near his farm, Snake Creek empties into the north branch of Henderson River. About two years ago somebody dumped two loads of dead hogs into Snake Creek, six miles above its junction with the river.

The stench soon became almost unbearable, and every hog or pig which had access to the creek or river became affected with swine plague. Mr. Morris at that time had a large herd of hogs, but he kept them shut up in his hog-lot away from the river, and his herd was the only one within six miles on that river which remained exempt.

8. *Mr. Morris's herd of swine.*—I was on his place for the first time on October 31. He had then about four hundred hogs and pigs or shoats, most of them running at large on a farm of 317 acres, and about forty or fifty of his shoats showed such symptoms as are observed during the first stages of swine plague. Only one animal had died (*cf.* below). He had bought, and received on October 18, a drove of hogs and shoats —about thirty head—out of an infected herd. Some of the animals belonging to that herd still exhibited symptoms of disease, but were considered as convalescent, while others appeared to be perfectly healthy, or showed only slight traces of having been sick. When I was there the whole drove was shut up by itself in a separate hog-lot, but had been driven over the farm, and was fed and taken care of by the same persons who attended to the other hogs. The first symptoms of sickness among Mr. Morris's old herd were noticed a few days ago, probably on October 25.

9. *Mr. Morris's herd again.*—On November 18, Mr. Morris informed me that to test whether a wound would absorb the infectious principle, he had, several days before, contrary to my advice, castrated a few (five) apparently healthy boar pigs, and had kept them separated from the diseased portion of his herd. When I was there (on November 18) three of these pigs were dead, and a fourth one was in a dying condition, notwithstanding the very mild form in which the disease was prevailing, especially in the herd of Mr. Morris.

10. *Mr. John Ragan*, near Biggsville, informed me on November 19 that his pigs commenced to show symptoms of disease just a week after they had been marked by cutting their ears. Swine plague was prevailing in the neighborhood.

11. *Mr. Pendarvis*, an intelligent farmer and dealer in cattle and hogs at Raritan, in the southern part of Henderson County, informed me on November 24 that a few years ago one of his neighbors lost nearly all his hogs. In his hog-lot was an old straw-stack, which served as a sleeping-place for the animals. A few months later this neighbor bought a healthy lot of hogs or shoats, and turned them into the hog-yard which contained the straw-stack. Swine plague very soon broke out among them, and nearly all died. A whole year later this neighbor again bought a healthy lot of hogs and turned them into the same yard which still contained the same old straw-stack, and soon the disease once more made its appearance, notwithstanding the fact that at that time no swine plague was prevailing anywhere in the neighborhood. After this the neighbor inclined to accuse the old straw-stack as the cause of the mischief, removed it promptly, cleaned his swine-yard thoroughly, and kept it free from old straw, &c. He has not had a case of swine plague among his hogs since the straw-stack was disposed of.

12. *Mr. Rickett's* herd, on Henderson River, three miles from Oquawka. I was on Mr. Rickett's farm on November 9. He has his herd of swine divided, and keeps one portion, about thirty head, in an inclosed yard on high, dry, and bare ground, free from straw-stacks and stagnant pools of water, where they receive their water for drinking from a well close to the fence. The other portion of his herd is running at large, and has access to the river. Among the latter swine plague has made its appearance, while the hogs which are kept in the yard are perfectly healthy.

Mr. Rickett stated that to his certain knowledge dead hogs have been thrown into the river above and have floated down past his place.

13. *Mr. William B. Graham's* herd, two miles from Biggsville. My first visit to his place was on December 29. Mr. Graham's herd consisted at that date of 127 hogs and shoats, a majority of which had been ringed late in October. The whole herd had the run of a large pasture and of a corn-stalk field, and slept till within two days in a huge straw-stack. The common feeding-place was around a corn-crib in the stalk-field, and the water for drinking was obtained from a small streamlet of running water flowing diagonally from northeast to southwest through the pasture. This small creek or streamlet has its source above, on the farm of one of Mr. Graham's neighbors, who also has his hog-yard or hog-pasture on the same streamlet, but above. In the early part of December, or (more likely) in the latter part of November, swine plague made its appearance in the herd of his neighbor, who immediately sold and shipped his whole herd, probably to Chicago, as soon as he found his animals sick and dying, or after he had lost a few. In Mr. Graham's herd the disease made its appearance, according to his statement, on December 21 or 22, but probably a few days earlier, because the first symptoms very likely had been overlooked. Up to December 29 three animals had died, and were hauled away early in the morning before my arrival by the "dead-hog man," or tank agent. I found from twenty-five to thirty animals unmistakably sick, about forty or fifty doubtful, and about fifty or sixty, to all appearances, perfectly healthy. Among the sick ones, which were all such as had been ringed—at that time no sick animal could be found among those that had not been ringed—about a dozen or more had badly swelled and ulcerating noses, and produced at each breath a snorting or snuffling noise. Although Mr. Graham, having invested in "sure-cure medicines," did not consent at that time to subject his herd to an experimental treatment, or did not give them into my charge, I advised him to separate the healthy animals from those evidently sick, and to remove the former to a non-infected place out of the influence of the infectious principle. When I visited him again, on January 10, he had made a separation, but had moved the healthiest or best portion of his herd to a piece of low ground, full of hazel brush and low scrubs, situated below and to the southwest of the old hog-pasture, and traversed by the same small creek. This was undoubtedly the very worst piece of ground to which he could have taken healthy hogs for protection, because all the water passing through that piece of ground came from the old hog-pasture, and the animals in consequence had to drink infected water. On January 10 most of the animals taken to that piece of ground, and constituting originally the best portion of the herd, had died; only a few were still alive.

14. *Mr. Campbell's herd at Monmouth.*—Mr. Campbell informed me on February 11 that a few years ago he had his hog-lot on the banks of a creek; swine plague broke out in his herd and nearly every animal died. He is sure the disease was communicated to his herd by the carcasses of dead hogs which floated down the creek.

The above facts and observations, which have not been observed by myself, have been communicated to me by reliable persons, whose veracity cannot be doubted. They corroborate my former conclusions concerning the infectiousness and the spreading of swine plague, as stated in my previous reports, and demonstrate especially—

1. That swine plague, very probably, is not communicated, at least not easily, unless the infectious principle (the Schizomycetes) is introduced either into the digestive apparatus with the food or with the

water for drinking, or directly into the blood through wounds, sores, scratches, or external lesions (*cf.* No. 4, W. H. Lord, and No. 12, Rickett).

2. That the carcass of a hog or pig that has died of swine plague will communicate the disease to healthy swine, if eaten by the latter before it is thoroughly putrified (*cf.* No. 2, Forward; No. 3, Hodson; No. 6, Whiteman).

3. That even frost is not sufficient to destroy the infectious principle, provided the Schizomycetes, which constitute the same, are not exposed for some time, for instance, on the surface of the ground, &c., to the direct influence of the low temperature, but protected against external influences by some organic substance (*cf.* No. 6, Whiteman, and No. 11, Pendarvis.)

4. That swine plague is readily and frequently communicated to healthy hogs by means of the water used for drinking, if it is contaminated with the infectious principle either by the carcass or parts of a carcass of a dead hog, or by the excrements, urine, and nasal discharges, saliva, &c., of the diseased animals, and that in many places a gross, and sometimes even criminal, carelessness is prevailing in contaminating and infecting the waters of rivers, creeks, streamlets, &c., by allowing diseased animals to have access to them, and by throwing in the carcasses of dead hogs, by which a considerable spreading of swine-plague is effected (*cf.* No. 2, Forward; No. 3, Hodson; No. 7, Morris; No. 12, Rickett; No. 13, Graham; No. 14, Campbell).

5. That one or a few diseased swine can, and frequently do, communicate swine plague to a whole herd of healthy animals by infecting the food or water for drinking by means of their dirty feet and noses, soiled with their excrements, urine, nasal discharges, saliva, or blood, as the case may be (*cf.* No. 5, Moir and Peterson; No. 8, Morris; No. 13, Graham).

6. That every wound, scratch, or sore on the surface of the body constitutes a port of entry for the infectious principle of swine plague, if the latter is prevailing in the immediate neighborhood (*cf.* No. 9, Morris; No. 10, Ragan; No. 13, Graham).

7. That an old straw-stack—any other porous body undoubtedly as well—may preserve the infectious principle for months, and even for a whole year (*cf.* No. 11, Pendarvis).

8. That the infectious principle (the Schizomycetes) enters the animal organism, and communicates the disease more readily and sooner through external sores and lesions than through the digestive canal or any other means (*cf.* No. 9, Morris; No. 10, Ragan; No. 13, Graham).

SWINE PLAGUE NOT LIMITED IN ITS ATTACKS TO SWINE.

That swine plague can be communicated to other animals besides swine has been demonstrated by the experiments of Dr. Klein, Professor Law, and myself, and also by several clinical observations; but the question as to whether swine plague can also be communicated to human beings is yet undecided, because such experiments, *inoculations*, necessary to decide that question, can be easily made on animals, but, for obvious reasons, not on human beings. As to the latter, we have to rely entirely upon clinical observation and accidental infection. The director (the late Prof. A. C. Gerlach) and the faculty of the Royal Veterinary School at Berlin, Prussia, officially gave it as their opinion in a report bearing date of February 25, 1875, that swine plague—"*hemorrhagische Follicular-Diphtherie des Dickdarms*" in the report—can be communicated to human

beings (*cf.* "*Gutachtlicher Bericht ueber verdorbene Leberwuerste*," communicated in Gerlach's "*Archiv fuer wissenschaftliche und praktische Thierheilkunde*," Vol. I, page 182). It may also not be out of place to relate a case that occurred last summer in Knox County, Illinois. A well-to-do and highly respectable family, residing near Yates City, lost, in last July, three children, aged respectively thirteen, five or six, and two and a half or three years, of a disease diagnosed by the attending physicians as diphtheria. The two remaining children of the same family also became affected, but recovered. Five physicians were in attendance, and made a careful research as to the possible cause or causes, and could find but one thing which might be construed as such. The family used ice which had been taken from a creek into which, above, some hogs (hogs that had died of swine plague) had been thrown just before the water of the creek became frozen. My informants are a highly respected physician in Biggsville, Dr. Maxwell, and a near relation of the afflicted family, Mr. John McKee, who has a drug-store in the same place.

FACTS AND EXPERIMENTS RELATING TO TREATMENT AND PREVENTION.

Considering it as one of the principal objects of my present investigation to ascertain what may possibly be accomplished in regard to treatment and prevention, or rather as to arresting the spreading of swine plague from herd to herd and from animal to animal by such means as are at the command of the farmer, and can be employed by every one who possesses common intelligence and an ordinary degree of watchfulness, I made quite extensive experiments with six different herds of swine, numbering from twenty-odd animals to about four hundred, or, on an average, about one hundred and fifty head each.

1. *Mr. Kennedy's herd.*—My first visit, as already stated, was made on October 14. Mr. Kennedy kept his herd of swine, of twenty-odd head, in a pasture a short distance from his house. He had recently bought a few pigs out of an infected herd, and thereby introduced the plague among his swine. I found three sick animals, among them one that was very sick. These three, on my advice, were immediately taken out of the pasture and put in an open pen by themselves, built expressly for them in the orchard. The other hogs or shoats were also taken out of the pasture and shut up in a yard, which had formerly served as a cattle-yard. The three diseased pigs were treated with hyposulphite of soda, of which they received each, three times a day, a (heaped) teaspoonful in their water for drinking. I further instructed Mr. Kennedy to feed and water each time, morning, noon, and night, first his healthy shoats and then the sick ones, and not to enter or go near the pen or yard of the healthy animals after he had been to the sick pigs. My directions, as far as I could learn, have been faithfully complied with in every particular; at any rate, the medicines have been promptly given according to my directions. My subsequent visits to Mr. Kennedy's herd were on October 17, 18, 21, 24, and 27. One of the sick pigs died on October 23 and another on October 26; only one of the three recovered, which, as I learned afterwards from Mr. Kennedy, was doing well and was again with the herd. Of the latter, only one animal exhibited once slight symptoms as if affected—it coughed some—and although my advice to separate it from the herd was not complied with, no further developments have taken place. The sick animal which recovered had only a comparatively slight attack of the disease, and with the care bestowed upon it—a clean, spacious pen, clean water, and clean food—

would probably have recovered even if no medicines whatever had been used. In this herd, therefore, the hyposulphite of soda probably failed to do any good, although it seemed during the first week of the treatment as if a slight improvement was observable, due, very likely, more to a change of quarters, clean water, and clean food—in the pasture the animals had access to a stagnant pool of water—than to the medicine. Still, whenever medicines are given, people, as a rule, are always inclined to ascribe every change for the better to their use.

2. *Mr. Gilchrist's herd.*—Mr. Gilchrist lives on a large farm, twelve or thirteen miles from Oquawka, on the Warren County line. My first visit to his place was on October 14. His herd consisted of over one hundred head of hogs and shoats, of which about forty showed more or less plain symptoms of disease. Several animals had died. I requested a division into at least three different lots, which may be designated as Nos. 1, 2, and 3. Lot No. 1, it was agreed, should only contain such animals as appeared to be perfectly healthy, and without any symptoms of disease; lot No. 2 was to be composed of such animals as did not appear to be perfectly healthy, but did not show any plain symptoms of swine plague; and lot No. 3 should include all those animals evidently sick. Lot No. 1, Mr. Gilchrist promised should be removed to a piece of ground—a small field without any water—which had been planted to corn, was free from any old straw or other rubbish which might possibly harbor any disease-germs, and was to be plowed the next day. Lot No. 2 he promised to put in another uninfected yard, separate from the regular hog-lot or pasture; and lot No. 3, it was agreed, should remain in the old hog-yard, occupied so far by the whole herd. It was further agreed that lot No. 1 should receive twice a day ten drops of pure carbolic acid in the water for drinking for 150 pounds of live weight, and lots Nos. 2 and 3 each, three times a day, a teaspoonful of hyposulphite of soda for every 150 pounds of live weight. Enough of each medicine was left to last from three to four days. When I made my second visit, on October 18, I found that only a part of the medicine, the carbolic acid, which had been given to the whole herd, had been used, and that no separation had yet been effected, because Mr. Gilchrist, on account of sickness, had been unable to perfect the necessary arrangements. The field or piece of ground intended for lot No. 1, however, had been plowed, and was ready for the reception of the animals. The plan of separation underwent a slight change as to lot No. 3, which it was thought best to divide again by putting the most seriously affected animals, lot No. 4, in a couple of open pens, situated in the barn-yard, and originally built for hog-pens, but unoccupied for a long time, and by leaving in lot No. 3, in the old swine-yard, only such animals as were evidently, though not dangerously, sick. It was further decided that lots Nos. 1 and 2 should be treated with carbolic acid, and lots Nos. 3 and 4 with hyposulphite of soda. On the whole the herd was not any worse than on my first visit, except that a few more animals were coughing. Only one animal had died, and a *post mortem* examination made of this, but the result was not very satisfactory on account of the high state of putrefaction. Another pig, however, about five months old, was killed by bleeding for the purpose of a *post mortem* examination. Result: Morbid changes (hepatization) in the lungs, and enlargement of the lymphatic glands, as usual; a few ulcerous tumors in the intestines; numerous entozoa (alive) in the choledochus, and some dead worms in the intestines. Went again to Mr. Gilchrist's on October 21 and 24, and found that all arrangements, as agreed upon, had been carried out. Lot No. 1 was on the plowed ground; lot No. 2 in another separate yard; lot No. 3 in the old hog-

lot; and lot No. 4, composed of seven very sick pigs, in a couple of small open pens in the barn-yard, separate from any of the yards occupied by the others. The medicines, too, had been given according to directions. On examining the several lots on October 24, I found in lot No. 1 a small pig, a so-called runt, that showed symptoms of disease. It belonged to lot No. 3, but being very small had crawled through the fence. It was immediately removed, and afterwards killed for *post mortem* examination. In lot No. 2 a sick pig was also found, which was likewise removed. In lot No. 3 nearly all the animals showed more or less plain symptoms of disease, but none were very bad or dangerously sick. Lot No. 4, as stated, contained the worst cases, and was originally composed of seven animals, but the number had been reduced to five, for one had died, and another had escaped over the rather low fence. Of these five animals, two, on examination, proved to be very sick.

The *post mortem* examination of the small pig, mentioned above, revealed the usual morbid changes in the lungs and in the heart to a limited degree, and nothing extraordinary except a firm adhesion (or union by firm connective tissue) between the posterior part of the left lobe of the lungs and the costal pleura.

Left more medicines—carbolic acid and hyposulphite of soda—with directions how to use them, with Mr. Gilchrist.

Went again to Mr. Gilchrist's on October 31, and found that the two very sick pigs and one of the others of lot No. 4, and a few of lot No. 3, had died, and that all others were doing well. In order to learn the final result I visited Mr. Gilchrist's herd once more, on December 16, and found that no deaths, and no plain cases of sickness, had occurred in lots Nos. 1 and 2, with the exception of the pig which was removed from lot No. 2 on October 24, and died afterwards. Lot No. 2 had been removed early in November to another yard or place, a piece of plowed ground. In lot No. 3 comparatively very few deaths had occurred.

It must be stated that during the whole experiment none of the hogs or pigs received any water except such as was pumped by a windmill from a deep well. Formerly the animals had access to a little streamlet proceeding from some springs. The medicines (the carbolic acid and the hyposulphite of soda) were given simply on account of their antiseptic and disinfecting properties, because there was reason to suppose that the water used for drinking, notwithstanding it was pumped from a deep well, might become infected, or be contaminated by Schizomycetes or disease-germs floating in the air while exposed. It was pumped by a windmill into a large and open wooden trough, situated in close proximity to the pens of lot No. 4, and adjoining on the other side the old swine-yard, occupied by lot No. 3. From this trough the water was carried in buckets to lots Nos. 1, 2, and 4, and carried by means of a pipe into lot No. 3.

3. *Mr. Henry Rice's herd.*—I visited Mr. Rice's place, about eight miles northeast from Oquawka, for the first time on October 17. His hogs and pigs had the run of the barn-yard and of two large pastures, one of which contained water, and had also access to the stack yard, which contained old straw stacks. I found nine decidedly sick animals, and five dead ones. Of the latter three were very much putrefied; one had died but two hours before, and the other died while I was there. Consequently I had an opportunity of making two *post mortem* examinations. The pig which had been dead two hours—an animal probably six months old and in good condition as to flesh—was examined first. The morbid changes were as follows: Lymphatic glands enlarged, blood coagulated and separated into dark clots and yellowish-colored serum,

one-third of the whole tissue of the lungs hepatized, the non-hepatized portions of the lungs partly filled with fluid exudation and containing innumerable small, reddish-brown specks, caused by extravasations of blood (these lungs constituted, in their mottled appearance, and with their numerous embolic hearths and extravasations of blood, a very characteristic specimen, and I regret that I was not prepared to have them photographed); some serum in chest and pericardium; all blood-vessels of the auricles of the heart turgid with dark-colored blood. In the abdominal cavity, one small, incipient ulcerous tumor and numerous worms (*Trichocephalus crenatus*); in cæcum, numerous ulcerous tumors in different stages of development; spleen very large and dark colored, and other organs destitute of any morbid features.

The other animal, a four months old boar pig, was examined immediately after death. The morbid changes were as follows: Lymphatic glands enlarged; blood of normal color; considerable exudation (serum and coagualtions, the latter principally on the anterior surface of the diaphragm) in the chest; over one ounce of serum in the pericardium; distinctly marked and fully developed hepatization only in the lower portions of both lobes of the lungs, but incipient hepatization or fluid exudation, and numerous small red spots of extravasated blood, each about a large as a pin's head, everywhere through the whole pulmonal tissue, but especially toward the lower border of the lobes; the capillary vessels of the heart, and particularly those of the auricles, turgid with blood. In the abdominal cavity: The whole peritoneum, but especially the serous coat of the intestines, congested, that is, all the smaller capillary vessels turgid with dark-colored blood; the intestines in many places agglutinated (adhering) to the walls of the abdominal cavity; the liver very dark and congested; the gall thick or almost semi-solid; the mucous membrane of the stomach wine-colored, and almost black, and very much swollen toward the pylorus; the mucous membrane of the duodenum black and gangrenous, and that of the jejunum purple and wine-colored; a large number of ulcerous tumors of various size in colon, and a few in cæcum; no entozoa or worms.

Neither of the two pigs presented any external morbid changes, except No. 2, which was slightly bleeding from the nose when it was dragged from the place where it had died to the place where the *post mortem* examination was made.

The following arrangements were made: The whole herd, some sixty odd head, was divided into two lots, No. 1 to contain the apparently healthy animals, or those not evidently sick, and No. 2 to be composed of seven very sick animals. On my arrival I found, as already stated, nine very sick pigs, but one died during my presence, and another was nearly half a mile from the barn-yard in the remotest of the two pastures, and was there left to its fate, as it was expected to die within a short time. The seven very sick pigs or shoats were shut up in a pen especially prepared for them, and lot No. 1, composed of those animals apparently healthy, was allowed to go to pasture (the one nearest the barn-yard) during the day, but was shut up in the barn-yard during the night, from sundown till ten o'clock in the morning, or till the dew had disappeared from the grass. The barn-yard was on high and dry ground, perfectly bare, and destitute of straw stacks, half-rotten manure, or pools of stagnant water. The pasture, too, was destitute of old straw, &c., and contained no water. The animals, therefore, received no water but what was drawn from a well in the barn-yard. Before my arrival the herd had access to running water in the remotest of the two pastures, and also to a stack-yard which contained old straw. All this was stopped.

Lot No. 1 was treated with carbolic acid in the water for drinking, the same as lots Nos. 1 and 2 at Mr. Gilchrist's place, because it was thought probable that the animals of lot No. 1 might pick up some disease-producing germs either with their food or with their water for drinking, which was exposed in an open trough after it had been pumped from the well. Lot No. 2, composed, as mentioned, of seven sick pigs shut up in a pen, was treated with hyposulphite of soda, a tea-spoonful three times a day for every 150 pounds of live weight, in the water for drinking. The first dose of that medicine was given in my presence in skimmed milk, and was taken by five of the sick pigs. One of them, after it had taken some, commenced to vomit, but soon went to the trough for more. Two had no appetite and refused to take anything.

The five dead pigs, the two examined included, were cremated in my presence at the place where the autopsies had been made. One sick pig, not under treatment, and apparently convalescent, was examined as to temperature, and was found to be only 101⅓° F.

Went again to Mr. Rice's place on October 18. The sick pig, left alone in the pasture, was dead, and had been cremated; the seven sick pigs in their pen (lot No. 2) were still alive. A "dead-hog man," that is, a man who travels with a wagon through the country to collect the dead hogs from the farmers for a rendering establishment, had called at noon, and come into the house while the family was at the dinner table. The stench emanating from his person and his clothes caused the whole family to vomit. No wonder, therefore, that such men are instrumental in spreading the disease wherever they go. Mr. Rice had ordered him to keep away from his premises. There is considerable suspicion in Henderson County, and elsewhere, that these "dead-hog men" find it sometimes in their interest to infect healthy herds of swine, expecially such as are nearly ready for the market, and therefore promise a rich harvest.

Finding that all my arrangements had been faithfully carried out, I left some more medicines (carbolic acid and hyposulphite of soda).

Went again to Mr. Rice's place on October 21. Of the seven sick pigs three had died, one had escaped while the gate was open, and three were still in the pen and alive. Of these latter I found two very sick, and about ready to die, while one was apparently improving, and convalescent. All the animals of lot No. 1 were doing well. My directions had been complied with in every particular.

Made another visit to Mr. Rice's place on October 27, and found that all the diseased pigs of lot No. 2 (the seven shut up in the pen, and treated with hyposulphite of soda) had died. The one that escaped had been caught and again confined, while all others (lot No. 1) which had been treated with carbolic acid in the water for drinking were doing first rate. So it seems that in this case the hyposulphite of soda has done no good as a curative remedy; even the one pig which seemed to be convalescent or improving on October 21 had died. Afterward, on December 18, I made one more visit, and learned that no loss whatever had occurred in lot No. 1, while in lot No. 2 every animal had died.

4. *The herd of Capt. Wm. Morris*, which, as has been mentioned, consisted of about four hundred animals. When I made my first visit on October 31, about forty or fifty animals were coughing, and exhibited more or less symptoms of swine plague. Only one animal had died, and as it had been dead but a few hours a *post mortem* examination was made. Morbid changes: Externally nothing abnormal, except a little redness between the fore legs. Internally: Enlargement of the lymphatic glands; extensive hepatization and numerous small extravasations of blood in the lungs; considerable exudation in the not yet hepa-

tized portions of the pulmonal tissue, which caused the lungs to fill the whole thoracic cavity. The substance of the heart appeared to be in a state of congestion, and not only the auricles, but also the ventricles of that organ presented their capillaries turgid with blood. In the abdominal cavity the only morbid changes that could be found consisted in incipient ulceration in the mucous membrane of the stomach. No entozoa or worms, neither in the bronchiæ nor in the intestines.

Mr. Morris promised, at my request, to divide his herd into several lots, and to separate the healthy animals from the diseased ones. I left two pounds of carbolic acid to be given to the healthy animals in the water for drinking, and a quantity of hyposulphite of soda for the diseased ones.

Went again to Mr. Morris's place on November 3. My directions had been complied with. The whole herd had been divided into six different lots, the diseased animals by themselves and the healthy animals by themselves, in different yards or inclosures. The medicines, the carbolic acid and the hyposulphite of soda, had been used and no deaths had occurred. It even seemed as if the appetites of the diseased animals had somewhat improved, and as if the coughing had become a little less. Still how much of the apparent improvement should be accredited to the medicines, how much to the clear and cold atmosphere—the thermometer indicated several degrees below the freezing point; how much to the continued dry weather—it had not rained for several weeks; and how much to the strict separation and the division of the large herd into smaller lots, is very difficult to determine. At any rate the disease prevailed in a very mild form in Mr. Morris's herd.

My next visit was on November 7, when I found the strict separation broken up on account of the scarcity of water—it had not rained for nearly a month. During the night the pigs were still kept in their respective pens and yards, but during the day four of the different lots had access to a common trough to get water. The arrangement was as follows: One well, separated by a fence, supplied two troughs with water. One of the troughs was placed in a swine-yard, occupied by about one hundred healthy hogs and pigs, and the other one was outside and furnished water for the four lots mentioned. The hogs and shoats recently bought by Mr. Morris, as before mentioned, composed the sixth lot, and were kept by themselves in the barn-yard, more than forty rods distant from the other swine-yards, and received their water for drinking from a well near the barn. I found nearly one hundred hogs and pigs, or about 25 per cent. of the whole herd, more or less coughing, a few thumping, a few limping, and some very much emaciated, but only one animal dead. The carbolic acid had been used freely in the water for drinking, and Mr. Morris is inclined to ascribe the unusual mildness of the disease (caused undoubtedly by a combination of circumstances) to its effect. Left more carbolic acid and some hyposulphite of soda.

On November 8 it commenced to rain, and continued for a week.

Went again to Mr. Morris' place on November 18. Found about 50 per cent. of the whole herd affected and coughing, but the disease was of such a mild type that only three animals, which had been castrated, had died, as has been mentioned before, or rather had been killed by Mr. Morris when he found them past recovery. One of these three had been dead only a day and had not yet been buried. It was in a first-rate state of preservation, and therefore a good subject for *post-mortem* examination. Morbid changes: Externally, a little redness of the skin on the lower surface of the body and between the fore-legs. Internally,

lymphatic glands swelled; adhesion, though not extensive, between left lobe of lungs and diaphragm; both lobes externally very mottled in appearance, and diseased in about an equal degree, but the hepatized portions and lobules alternating with almost healthy portions, and in the latter numerous extravasations of blood presenting themselves as small red spots.*

Those parts and lobules not yet hepatized, or perfectly impassable to air, contained considerable exudation still in a fluid condition, and some of the smaller bronchiæ, especially those in the posterior portions of the lungs, harbored a very large number of very fine thread-shaped worms (*Strongyli paradoxus*). As other morbid changes, may be mentioned several ounces of serum in the chest, and more than one ounce in the pericardium. There was nothing very abnormal in the abdominal cavity. The dead pig was an animal about seven months old, and in a fair condition as to flesh.

November 22.—The disease had developed a more malignant character. Over two hundred animals were sick; from forty to fifty were very bad, and several deaths had occurred. Ordered once more a strict separation, which had become possible, since abundant rains had removed the scarcity of water; gave some carbolic acid, and some salycilic acid, and some hyposulphite of soda, to be tried on different lots, with instructions how to use it.

The continued rainy weather, the exceedingly bad conditions of the roads, and the great distance of Mr. Morris's place from Oquawka, (about fifteen miles), prevented me from making another visit during the month of November. I was, however, informed by letter, dated December 1, that the separation had been carried out, the medicines used according to directions, and that only a few animals had died, and all those slightly affected were recovering. I made afterwards, on December 18, another visit, and found the separation broken up again as soon as an improvement became apparent. Still, comparatively few animals, the exact number I was unable to learn, had died. Found one dead animal when I was there. The *post-mortem* examination revealed the usual morbid changes in the lungs, heart, pleura, pericardium, and lymphatic system, but no morbid changes of any consequence in the abdominal cavity, except enlarged glands and somewhat degenerated pancreas.

5. *The herd of Mr. Ely Beaty*, about four miles from Oquawka. This herd consisted of about one hundred head of hogs and pigs, and was visited for the first time on December 20. Found two pigs dead and five very sick. The herd was divided into two portions, and had been

* The illustration, Plate II, presents the external surface of the left lobe, photographed from nature, but a little reduced in size, and somewhat distorted in shape on account of its weight while suspended before the camera. The central portion of the plate is a good representation, and shows the mottled appearance of the lobe, but the left and upper portion of the plate are poor, and were evidently not in focus. The microphotographs, Plate III, figs. 1 to 6, were taken from slides of transversal sections of pulmonal tissue of the right lobe of the same lungs. Fig. 1, Plate III, taken from a very thin section, shows nearly all the pulmonal vesicles perfectly closed; fig. 2 shows diseased pleura and small blood extravasations; fig. 3 is from a very thin section, and shows diseased and thickened pleura. The normal pulmonal tissue is recognizable, notwithstanding the pulmonal vesicles are more or less filled with exudation; fig. 4 shows extravasation of blood and hepatization, but the structure of the pulmonal tissue can still be recognized; fig. 5 shows in its upper portion a blood vessel completely filled with blood; and fig. 6, which was taken from a thicker section, not stained, presents partially hepatized pulmonal tissue, in which the shape and form of the pulmonal cells are yet visible. Figs. 1 to 5 were taken from sections stained with Kleinenburg's solution.

for some time. About thirty of the older and larger animals were kept in a high and dry pasture close to the house, and were said to be healthy; consequently I had nothing to do with them. The other portion of the herd, composed of about seventy, mostly small and young animals, among which the cases of sickness and death had occurred, occupied the barn-yard, and were allowed to roam on a large uncultivated tract of very broken land partly timbered. This (infected) part of the herd was immediately divided; all animals apparently healthy were removed to the orchard, and the diseased ones were allowed to stay where I found them. Two other pigs were kept in an open pen adjoining the barn, and separated from the barn-yard only by a fence. These were not disturbed, received no medicines, and did not become affected. The apparently healthy pigs removed to the orchard were treated with carbolic acid in the water for drinking, the same as lots Nos. 1 and 2 of Mr. Gilchrist's, and lot No. 1 of Mr. Rice. No medicines were given to the five sick pigs, because they were small, emaciated, of little value, and were not expected to recover. On December 22 three of the sick pigs had disappeared and could not be found; they had probably wandered off to a nook in one of many ravines, and there died.

December 27.—No new cases of disease, except in that portion of the herd composed of the older animals which were kept in the pasture. An old stag, which had been castrated only a few weeks before, was found dead. According to the information received, it had shown symptoms of inflammation of the brain for about twenty-four hours before its death. It died on December 26. Putrefaction had set in, but a *post-mortem* examination was made for the purpose of learning whether the animal was affected with swine plague or had died of another disease. External morbid changes: the skin on the lower surface of the body purplish-black; the castration wounds not fully healed; and the spermatic cords inflamed, enlarged, and almost black. Morbid changes in the chest: distinctly limited hepatization in the lower anterior or small lobes of the lungs; numerous unusually large extravasations of blood in the pulmonal tissue; the heart very much enlarged, about twice its normal size, and full of dark-colored blood, only partially coagulated; several ounces of serum in the pericardium. In the abdominal cavity nothing could be ascertained with certainty, as putrefaction was very much advanced. The skull was not opened, because no instruments were at hand. There can be no doubt the animal was affected with swine plague, but it is doubtful whether death was caused by that disease or by something else—for instance, by an overdose of salt or brine; at any rate, the symptoms observed during life, if correctly reported, would justify such a conclusion.

Visited Mr. Beaty's herd once more in January, and found that the five pigs which were sick on December 20 had all died, and that none of the others, with the exception of the old stag, had exhibited any symptoms of disease. After the 20th of December all received their water for drinking from a well close to the house. Before that date, the larger portion of the herd (the one kept in the barn-yard) had access to several small streams of running water.

6. *Mr. William B. Graham's herd*, two miles from Riggsville.—This herd has already been mentioned. I made my second visit to Mr. Graham's place on January 10, principally for the purpose of obtaining fresh material for experimental purposes. About fifty animals of his herd had died, notwithstanding the use of "sure-cure medicines," and most of the hogs and pigs still alive were more or less affected. Mr.

Graham was not at home, but as several dead pigs were lying about unburied, I was permitted to make a *post-mortem* examination and to take all the material wanted. I chose a barrow about six months old, which had died, probably, not over an hour before. The carcass, which was but little emaciated, presented the following morbid changes: The skin on lower surface of abdomen, between the fore-legs, &c., was of a reddish-purple color; lymphatic glands enlarged; about five or six ounces of yellowish or straw-colored serum was found in the chest; about three-fourths of the whole pulmonal tissue of the left lobe and more than one-third of the pulmonal tissue of the right lobe of the lungs was morbidly changed, that is, presented hepatization in various stages of development, and, therefore, a mottled or marbled appearance; at several places there was adhesion between pulmonal and costal pleuras, and between pulmonal pleura and diaphragm; a few *Strongyli paradoxi* in the finer bronchiæ of the posterior portions of the lungs, but none anywhere else; about half of the whole surface of the pulmonal pleura, even where not adhering to the wall of the chest, coated with exudation and rough; heart but little changed; some serum in pericardium. In the abdominal cavity, stomach entirely destitute of any food, but containing several entozoa and a quantity of yellowish mucus; spleen enlarged to about three times its normal size; pancreas somewhat changed, presenting on its external surface small yellowish specks, resembling detritus; bile dark colored and thick; liver, sub-venal glands, and kidneys without any visible morbid changes; large intestines almost without any food or feces, but containing a considerable quantity of intensely yellowish-colored mucus; no ulcerous tumors anywhere, but mucous membrane of large intestines somewhat swelled or thickened. I took pieces of the anterior portions of both lobes of the lungs and one of the glands of the mediastinum for further examination and for experimental purposes (*cf.* below).

Went again to Mr. Graham's, at his solicitation, on January 12, when he asked me to take charge of his herd and promised to comply with my directions in every particular. Of the one hundred and thirty hogs and shoats originally constituting his herd about seventy had died, forty-nine were yet eating, though by no means perfectly healthy or free from any infection, and the others were more or less sick, some of them dangerously. The forty-nine animals mentioned were removed to a large pen or inclosure made for them in the orchard, on high and dry ground, where they received clean food (corn) and no water except such as was pumped from a well. The inclosure was free from old straw, rubbish, &c., and the ground was bare. In my former experiments I treated the diseased animals with hyposulphite of soda, and met with very poor success, and used carbolic acid as a preventive medicine. In this present case I concluded to put the well-known antiseptic and disinfecting properties of the hyposulphite of soda to a test, and to give that drug as a preventive and in somewhat larger doses than formerly—three times a day a tea-spoonful to every hundred pounds of live weight—in the water for drinking to the forty-nine animals shut up in the orchard. The other shoats which were evidently sick I left to the treatment of Mr. Graham, with some "sure-cure medicine" of some Iowa men, styling themselves, I believe, "The National Hog Cholera Company." It may be remarked here, to avoid repetition, that Mr. Graham's hogs (those separated and kept in the inclosure in the orchard) consumed from January 12 to February 8 twenty-five pounds of hyposulphite of soda furnished by me and several pounds (four or five)

bought by Mr. Graham; or each animal, on an average, consumed about three-fifths of a pound.

January 17.—Mr. Graham had been obliged to remove from the inclosure in the orchard (out of the forty-nine) one decidedly sick animal. Among the forty-eight thus left several were coughing and looking rather gaunt, but most of them were doing very well.

January 19.—Nearly all of the forty-eight hogs and shoats are doing well, and only a few show symptoms of disease, while most of the others (those found to be sick on January 12) are dead. A heavy rain converted the ground of the inclosure into mud and made it very uncomfortable for the animals. Mr. Graham, therefore, with my consent, enlarged the inclosure and took in a larger piece of the orchard. The treatment otherwise remained the same.

January 24.—Went again to Mr. Graham's. Of the original forty-nine hogs and pigs, forty-four were yet in the inclosure; four sick ones had been taken out and removed to the barn-yard, where a few other sick ones were kept. In all forty-six of the original forty-nine were alive; five had been removed, and of these two were still living. Of the others only a few were yet alive. Eleven or twelve dead hogs and pigs were piled up in a heap close to the barn and two others were lying in a fence-corner. I would have insisted on their burial or cremation, but the whole premises were already about as much infected as possible, and I thought that by allowing things to go on in the same way it might make the test of the hyposulphite of soda more severe and more valuable.

My next visit was on January 27. Found a few animals among the forty-four in the orchard still coughing. The dead pigs were still lying unburied.

January 30.—Found everything unchanged. The forty-four pigs in the orchard were doing well.

My last visit was on February 4. Found the forty-four hogs and pigs in the orchard all doing very well; those that had been coughing or showing other slight symptoms of disease were recovering, and all others had gained in flesh. When called up to be fed in my presence every one responded with alacrity and appeared greedy. Of the original forty-nine, forty-five were alive and doing well; five had been separated, and of these four had died. Of all others two or three were alive, except two boar pigs, which had not been with the herd, but had been kept in a separate pen and had not become affected. The dead shoats were still lying around in the same places, and one pig which had died two days before was even lying in the barn. I therefore urged Mr. Graham to burn every dead animal at once and not wait any longer for the "dead-hog man" to come around. I learned afterwards, by letter, dated February 16, that one more of the sick pigs had died, while no new case of disease had occurred.

Several other herds of swine, either diseased or reported to be diseased, were visited, partly for the purpose of selecting suitable herds for experimental purposes, but principally to obtain all the information possible by my own observation and from what the owners might have to communicate of their experience.

At Mr. Cortleyou's place I found one dead hog, and a *post mortem* examination was made, which, however, revealed nothing new, except that the lungs adhered almost everywhere to the walls of the chest. The plumonal and costal pleuræ were, at several places, so firmly united as to make it impossible to open the chest, and to remove the ribs without

tearing the tissue of the lungs, or separating them by means of the knife from the walls of the chest.

At Mr. Radmacher's three *post mortem* examinations were made at his solicitation, but the disease did not prove to be swine plague; no morbid changes were found except an immense number of small acephalous cysts or hydatids, situated on the serous membrane of the small intestines.

At most of the places named I obtained some valuable information as to the means and vehicles by which swine plague is spread, corroborating in every respect what I found before. As of special interest the experience of Mr. John Haley deserves a brief mention. Mr. Haley is a farmer of superior intelligence, a good observer, and well acquainted with the symptoms of swine plague in all its various phases. His herd of swine consisted (in October) of sixty animals. Last July one of his pigs exhibited plain symptoms of the plague. In order to prevent, if possible, further mischief, he killed the affected animal at once, and buried it four feet deep. He acted in time, because no other animal had yet become infected, and his herd was saved. If swine plague were everywhere dealt with in like manner as soon as it makes its appearance the losses would be very few.

EXPERIMENTS WITH HEALTHY PIGS.

The observations in regard to the spreading of swine plague from place to place, from herd to herd, and from animal to animal, and the results obtained in the treatment and the measures of prevention applied to the six herds experimented with, made it desirable to determine with certainty three important points. First, although my observations left no doubt in my mind as to the disease being frequently, and probably in a majority of cases, communicated by means of contaminated or infected water for drinking, absolute proof was yet wanting, which, it seemed to me, was obtainable only by a direct experiment, in which positively healthy pigs, while protected against any other possible source of infection, are compelled to drink water contaminated or infected either with parts of a carcass of a hog that has died of swine plague, or with the excrements, excretions, or secretions of an animal affected with that disease. Second, the results of my experiments in regard to measures of prevention proved to be exceedingly favorable, and notwithstanding the uncommon leniency of the disease in four or five herds experimented with—in the sixth one, that of Mr. Graham, the plague proved to be malignant enough—it cannot be denied that the measures of prevention employed were attended with very good and satisfactory results, and effective; but the question remained to be answered whether the good results were due mostly, or exclusively, to the strict separation, which undoubtedly was of the greatest importance, as it prevented, to a certain extent at least, a further influx of the infectious principle, or whether the same were chiefly the effects of the disinfecting and antiseptic properties of the carbolic acid and the hyposulphite of soda, administered in the water for drinking, notwithstanding that three drops of carbolic acid added to three ounces of water infected with one drop of pulmonal exudation (in an experiment made June 9, 1879), did not seem to be able to destroy the Schizomycetes, or to prevent altogether their development. This question, too, could be answered only by subjecting an undoubtedly healthy pig to the influence of the infectious principle in such a way as would surely bring on the disease, and by treating it at the same time with one of those

medicines. Third, I considered it as desirable to subject the vitality, or rather effectiveness of the Schizomycetes, or of the infectious principle, to a practical test after they had been preserved for a long time (nearly a year) in a suitable vehicle outside of the animal organism. In order to decide these points, I procured three perfectly healthy and vigorous pigs, free from any wounds or sores, each about four or five months old, and weighing about ninety pounds. (The three together weighed 265 pounds.) In the midst of a large empty lot, on high and dry ground, and inclosed by a good substantial board fence, which permitted no animal larger than a chicken to crawl through, I built them a pen of new lumber especially designed for my purpose. The pen measured 12 by 8 feet, had a good board floor and a board roof, and was divided by partitions, 4 feet high, into three separate apartments, each 8 by 4 feet. The troughs, one for each apartment, were so made as to facilitate cleaning and removing of the same if desired. I received those pigs on January 9, kept them a few days for observation as to their health, and commenced my experiments on January 11. It was at first my intention to procure for two of these pigs some water from an infected creek or streamlet, but winter weather, frost, bad roads, and a distance of seven miles or over between Oquawka and the nearest streamlet known to be infected, caused me to abandon that project, and induced me to substitute well-water infected on purpose with infectious material. I procured the latter—pulmonal exudation, which, undoubtedly, is neither as infectious, nor does it contain such an immense number of Schizomycetes as the excrements and other excretions of a diseased pig—from Mr. Graham's herd. The water was drawn fresh (three times a day) from a good well, poured into the troughs, and then contaminated or infected for each pig, Nos. 1 and 2, with a few drops of the pulmonal exudation. Pig No. 1, which occupied the west end of the pen, and pig No. 2, which was kept in the middle apartment, received such infected water for drinking during four successive days, or from the evening of January 11, till noon January 15. Pig No. 1 received no medicine whatever, and pig No. 2 received each time, together with the pulmonal exudation, six or seven drops of the concentrated carbolic acid (95 per cent. of Mallinckrodt's cryst. carbolic acid, and 5 per cent. of water) in the water for drinking. Pig No. 3, occupying the eastern part of the pen, was subjected to another experiment, and received clean water, clean food, and no medicines of any kind. Last winter (in January, 1879), while investigating swine plague in Lee County, I had occasion to filtrate infectious pulmonal exudation, somewhat diluted with water, for the purpose of freeing the same from the Schizomycetes or disease-producing germs. I made repeated efforts, and used filtering paper, but did not succeed. The filtrate, however, which was perfectly clear, was preserved in a vial with a tight-fitting glass stopper. Repeated microscopic examinations (April 13, July 26, November 15, and January 11) showed that the Schizomycetes had not disappeared, and had undergone but very slight changes (*cf.* drawing, Fig. XV). It was therefore to be supposed that the filtrate, which was yet clear and transparent, and without any smell whatever, might still possess its infectious properties. Consequently I concluded to use that old filtrate for the purpose of testing the tenacity of life of the infectious principle, and injected on January 12, 20 minims of the same by means of a graduated hypodermic syringe into the cellular tissue, just behind the fore-leg of pig No. 3.

January 12 to January 25.—All three pigs appeared to be perfectly healthy, and had good appetite; at least none of them exhibited any signs or symptoms of disease.

January 26.—Pigs Nos. 1 and 2 appear to be healthy, and have good appetite. Pig No. 3, the one inoculated with the old filtrate, shows plain signs of indisposition, such as drooping of the head, considerable coughing, and partial loss of appetite.

January 27.—Pig No. 1 shows unmistakable symptoms of disease, such as coughing, drooping of the head, loss of appetite, &c., and is less lively in its movements than formerly. Pig No. 3 coughs repeatedly, and has very little appetite, but is apparently thirsty. Both pigs (Nos. 1 and 3) have lost the curl in the tail. Pig No. 2 is perfectly healthy, and has a vigorous appetite. This pig has received no carbolic acid during the last four or five days, but now receives it again regularly three times a day, each time six to seven or eight drops in its water for drinking.

January 28.—Pig No. 1 is worse, coughs a good deal, droops its head, eats scarcely anything, and is very thirsty, but is still savage when touched. It may be remarked here that all three pigs, being of "scrub" stock, with a slight mixture of Poland China and Berkshire, and having been raised in a large herd, accustomed to large fields or pastures, were naturally very savage, which made a close examination exceedingly difficult. For the same reason I found it impossible to ascertain the temperature without using force, and causing thereby an abnormal rise. Pig No. 3 coughs repeatedly, breathes faster than usual, eats very little, is thirsty, and its coat of hair looks rough. Pig No. 2 is perfectly healthy; its coat of hair is sleek and smooth.

January 29.—Pig No. 1 is worse, and evidently suffering. Its respiration is very much accelerated; the coughing is worse and more frequent; the thirst is increased; appetite is wanting, and the coat of hair is looking rough and unclean. Pig No. 3 eats a little more, but still coughs very much. Pig No. 2 has a vigorous appetite, and is perfectly healthy.

January 30.—Pig No. 1 coughs a great deal, is evidently in distress, and does not touch its food. Its coat of hair is rough, and emaciation is visible. Pig No. 3 has more appetite, eats about half its usual ration, and appears to be livelier, but is still coughing. Pig No. 2 is perfectly healthy.

January 31.—Pig No. 1 about the same as yesterday; at any rate not worse. Pig No. 3 is improving. Pig No. 2 is all right in every respect.

February 1.—Pig No. 1 eats some, but is coughing a great deal, and is thirsty. Pig No. 3 eats more, but not a full meal, coughs less, breathes freer, and its coat of hair looks less rough. Pig No. 2 eats vigorously, and is healthy.

February 2.—Pig No. 1 eats some, about half a meal, and don't seem to be as thirsty as formerly. Pig No. 3 eats nearly a full meal, and coughs very little. Pig No. 2 is all right.

February 3.—Pig No. 1 is improving, eats about half a meal, but is still coughing. Pig No. 3 has regained its appetite, and coughs very little. Pig No. 2 is as healthy as ever.

February 4.—Pig No. 1 is improving, eats more than half a meal, and coughs but little. Pig No. 3 has a good appetite, and seems to have fully recovered from its slight attack. Pig No. 2 is perfectly healthy, and the use of carbolic acid is dispensed with. It has received in all a little over half an ounce. Have never heard it cough.

February 5.—Pig No. 1 is improving, eats nearly a full meal, coughs very little, and its coat of hair is smooth again. Pig No. 3 has fully recovered, and pig No. 2 is healthy.

February 6.—Pig No. 1 eats well again, and shows no sign of disease, except now and then a little coughing. Pigs Nos. 2 and 3 are healthy and ready for another experiment. When the three pigs were received, pig No. 1 was slightly heavier than pig No. 3, and weighed over ten pounds more than pig No. 2. At present (February 6), pig No. 2 is the heaviest, and weighs at least twenty pounds more than No. 1, and ten pounds more than No. 3.

When pig No. 1 commenced to show signs of recovery, pig No. 3 had only a very slight attack, and was not expected to die. I thought of killing it for the purpose of ascertaining the extent and the nature of the morbid changes existing, but as I intended to make more experiments, and as it is not easy to obtain suitable material when wanted, I concluded to allow the animal to recover, and to save it for further use, but on February 8, I was taken sick myself, and was thus compelled to abandon my plans for the time being. From February 6 to February 12, the day on which I left Oquawka, all three pigs were doing well and improving.

MICROSCOPIC EXAMINATION.

Special attention has been paid to the examination of the water of such running streamlets, small creeks, and stagnant pools as were ac-

cessible to diseased hogs. Most of the water examined under the microscope was taken from small runs, ravines, and pools of the hog-pastures of Messrs. Kennedy, Gilchrist, Rice, and Morris, but samples from other places have also been examined. The objectives used were a one-ninth imm., or No. 8 Hartnack, a one-sixteenth imm., or No. 10 Hartnack, and a one-tenth oil or balsam-index imm. of Tolles, of recent make and superior quality. The results, in all cases, have been essentially the same. Besides some algæ and other minute growths, I always found some globular and rod-shaped Schizomycetes, to all appearances identical to those which occur invariably in the blood, lymph, exudations, other morbid products, excrements, urine, &c., of the hogs and pigs diseased with swine plague (*cf.* drawing, Fig. XVIII). It must be stated, however, that every sample of water was taken from such a place in the streamlets or pools where the water was known to have been more or less defiled by diseased hogs.

The blood, exudations, &c., of nearly every animal of which a *post mortem* examination was made, were also subjected to a microscopical examination. Special care was taken in every instance to collect the blood directly out of a blood-vessel in perfectly clean, so-called homœopathic vials, which were closed immediately with new corks. The results have been essentially the same as those obtained last winter (*cf.* next chapter).

The fact of finding globular and rod-shaped Schizomycetes, apparently identical to those occurring in the diseased hogs, in all the samples of water taken in perfectly clean vials from such small creeks, ravines, and pools as had been used as drinking and wallowing places of diseased hogs, convinced me still more that a communication of swine plague from one animal to another, and from one herd to another, is frequently, and may be in a majority of cases, effected by means of the water for drinking, if defiled by diseased hogs, or contaminated with the morbid products of the disease or the carcasses of dead hogs. That such is the case received additional proofs by the results of my experiments and the good services of the carbolic acid and the hyposulphite of soda mixed with the water for drinking, but particularly by the result of the experiment with experimental pigs Nos. 1 and 2. If it were not so, the carbolic acid especially, it must be supposed, could not have had much effect.

THE SCHIZOMYCETES.

In my former reports I adopted the name of "*Bacillus-suis*" for those globular and rod-shaped parasites of the Schizomycetes family which are invariably found in the blood, the morbid products, the excretions, the secretions, &c., of swine diseased with swine plague, and which, for reasons stated in my previous reports, I am obliged to look upon as constituting the infectious principle and the real cause of that disease, for the following reasons: I called those Schizomycetes, when presenting themselves in their rod-shaped or higher developed form, "*Bacilli*" (little sticks), partly on account of their stick-like shape, and partly on account of their, in many respects, close relation and similarity—by constituting the cause of an almost equally destructive disease—to the well known "*Bacillus anthracis*," and I gave them the name "*suis*" from *sus* (swine) as constituting the cause and infectious principle of a disease peculiar to that animal, though communicable, under favorable circumstances, to others. I was then, however, not sufficiently acquainted with the exact classifications of the various disease-producing Schizomycetes, as made by different European authors, such as Cohn,

Billroth, Klebs, and others, and I would not have attempted to name them at all had I found them named or sufficiently described by any one else. Since then I have worked considerably with the microscope, and have become somewhat familiar with the classifications adopted by the Europeans, which, it must be regretted, differ widely, and, owing to almost insurmountable difficulties, are yet unsatisfactory. All, however, seem to agree that those Schizomycetes classed by them under the name of "*Bacillus*" do not form clusters or colonies (Rasen, *zooglœa*-masses, *gliacoccos*, or *coccoglia*), and do not undergo metamorphoses from globular to rod-shaped Schizomycetes, two things decidedly characteristic of the microscopic parasites of the Schizomycetes family as found in swine plague; consequently the name adopted, *Bacillus*, was not well chosen, and is not suitable. Cohn, considered as one of the best authorities, discriminates *Sphærobacteria*, *Microbacteria*, *Desmobacteria*, and *Spirobacteria*, and divides the former in *Chromogenic*, *Zymogenic*, and *Pathogenic Sphærobacteria*. According to his classification the Schizomycetes of swine plague, in their globular form, would come under the head of *Pathogenic Sphærobacteria*, and in their rod-shaped or stick-like form under the head of *Microbacteria*, under which he arranges only two species, *Bacterium termo*, and *Bacterium lineola*, neither of which is identical to the rod-shaped Schizomycetes of swine plague. *Bacterium termo* is much more lively in its movements than the latter, which, also, invariably disappears as soon as *Bacterium termo* or putrefaction *bacterium* makes its appearance in large numbers, and *Bacterium lineola* is considerably larger. *Bacillus anthracis* is classed by Cohn among the *Desmobacteria*, of which he gives it as a characteristic that the same never form any clusters or *zooglœa*-masses. *Spirobacteria* (see sub. IV in drawing in my first report) have been found a few times, but I am convinced their occurrence was accidental.

Billroth makes a different classification, and objects to a separation of the globular from the rod-shaped Schizomycites, as both forms belong to several species, and constitute only different stages of development. According to his classification the Schizomycetes of swine plague would come under the head of *Coccobacteria*, and might be called *Coccobacteria suis*.

Two of my drawings (one sub. VII in my first report, and another one in my second) present club-shaped bacteria or Schizomycetes. These, according to Billroth, are *Helobacteria*, and constitute a higher development of *Coccobacterium*. The bright and light-refracting granules or globules which constitute the knob, situated in some of the *Helobacteria* at one end, and in others further toward the middle (*cf.* drawing in my second report), are capable, according to Billroth, of enduring high degrees of heat and cold, and may even completely dry up without being destroyed, or losing their germinating power. If moistened and swelled again in a sufficiently wet or watery substance, they will produce a great many very fine and pale spores (*micrococcos*), which are usually enveloped in a pale viscous substance (glia); such a group of spores, colony, or cluster (*gliacoccos* or *coccoglia*), remains for some time together, or at rest. These spores, or *micrococcos*, can multiply by division, and afterwards either remain together as irregular-shaped clusters, or *coccoglia*-masses, or in form of chains (*streptococcos*); or, if the glia formation is destroyed, multiply further as single *micrococcos*. In most cases, however, these spores, or *micrococcos*, which have come forth from the *Helobacterium*, soon stretch or grow lengthwise, and become rod-shaped bodies (bacteria). In fluids these bacteria, after some time of rest, commence to move, work themselves out of the glia or viscous substance, and

swim about in the fluid (swarming vegetation-spores, or swarming bacteria). During this swarming period and later, after they have found somewhere a place of rest, these bacteria begin to stretch or to grow longer—sometimes very long; a traverse furcation appears in the middle; the ends commence to swing to and fro, and finally a separation takes place, and the long bacterium is divided into two. Usually the ends divide again and again, till finally the joints sometimes become so short as to be not much longer than thick. In other cases only lines of demarcation are formed, and an actual separation does not take place, at least not at once. In such a case the joints are first square, but soon become round, and then the *bacterium* (*strepto bacterium*) resembles a *coccos* chain. If the *glia* which envelops the crecos-colonies, from which the bacteria come forth, is very thick and tough, and if the bacteria part from each other by separating continually, new glia and no chains are formed, then confluent and resting (motionless), *Glia* and *Petalobacteria* are produced, and their elements, especially on the surface of a fluid, can vegetate for a long time without obtaining motion.

According to Billroth the final changes of the bacteria and bacteria chains, which have been without motion from the beginning, or have come to rest after a period of swarming, may differ as follows: 1. The plasma may pass out of the envelope in form of a sterile viscid substance, and the empty envelope remains. 2. The plasma may become crenated in different directions (moniliform), while the envelope remains; the crenation leads to separation, and pale globules (*micrococcos*) are formed, which multiply more and more within the envelope, and growing, roundish-shaped, palmelloid-ramified, and cylindrical cells or sacs, full of micrococcos (*ascococcos*) are produced. These cells or sacs finally break or dissolve, and the micrococcos become free. What becomes of them Billroth leaves undecided. 3. The plasma of a bacterium contracts to one or more shining or light-refracting globules, with dark outlines, and thus the *Helobacteria*, commenced with, are formed.

As nearly all these various changes and formations have been repeatedly observed, it may be that these club-shaped formations, or *Helobacteria*, of Billroth, which I was inclined to look upon as foreign to the disease, are only a higher development, or another form of the swine-plague Schizomycetes.

Klebs has the same objections to Cohn's classification as Billroth, but does not agree with the latter. He divides the Schizomycetes (Naegeli), which he calls Schistomycetes, into two groups, *Microsporines* and *Monadines*. According to his classification the Schizomycetes of swine plague would come under the head of the former, of which it is a main characteristic that the same do not develop any offensive gases, like the members of the second group, the *Monadines*.

It may be asked, which of the various forms presented in the drawings represent the true swine-plague producing Schizomycetes? I will try to answer as well as I can. In the first place, the drawings, especially those accompanying my first report, are not as accurate as I desired them to be, because I am no draughtsman, and in the beginning of my investigation had to work with objectives—my best lens was a No. 8-im. Hartnack, much inferior to those I have now, a one-tenth Tolles and No. 10 Hartnack; therefore I had difficulty to get sharp and accurate outlines, and still greater difficulty in reproducing them on paper. Secondly, a great many Schizomycetes, being so exceedingly small, appear to be very similar to each other; especially *Bacterium termo*, so often met with, is very similar in appearance to the rod-shaped Schizomycetes of swine plague, and unless a very superior lens of high

magnifying power is used, a Tolles $\frac{1}{10}$, for instance, can sometimes hardly be distinguished from the latter, except by its livelier movements, which, of course, cannot be shown in a drawing. Two or more species of Schizomycetes may be very similar in appearance, or so nearly alike as to make a discrimination impossible, and still they may possess entirely different properties, and produce very different effects. The following may serve as an illustration: The pigment-bacteria, or *chromogenic sphaerabacteria* of Cohn, are all alike and cannot be distinguished, and still the various species produce different colors, but each species invariably the same. One, for instance, produces green, another red, another blue, another orange, and so on. The Schizomycetes of swine plague and those of putrefaction, though similar in form, are entirely different in their effect, and even antagonistic to each other in so far as the former, as has already been stated, commence to disappear as soon as the latter make their appearance. To show the visible difference between the swine plague Schizomycetes and *Bacterium termo* I refer to drawing, Fig. XIX *a* and *b*, which represents the latter after Siedamgrotzky and Cohn.

Not all the small particles, however, which are sometimes seen swimming in the blood or blood serum, and may even show a slight motion, are micrococci, or globular Schizomycetes; some of them are products of detritus, or minute fat globules, &c. But those minute globular bodies, which strongly reflect the light, are sometimes even more numerous than the blood-corpuscles, and are not destroyed by adding a weak solution of caustic potash, must be considered as micrococci, or globular Schizomycetes. Further, where clusters or colonies (*gliacoccos or zoogloea*-masses) are existing, and where rod-shaped Schizomycetes or bacteria are accompanying the spherical forms, then no doubt can remain. There are yet several other means by which their true nature can be determined, but to enumerate them would lead too far, and will not be necessary. One other point, however, may yet be mentioned. If the small globular bodies, seen under the microscope, are detritus or minute fat-globules, they will, at best, remain as they are, but will not propagate or increase in numbers like the micrococci, which multiply or propagate in many other fluids besides blood, if put into them, and even in fluids entirely different from that in which they have been found. In other words, the micrococci can be cultivated, and detritus and fat-globules cannot.

Under some circumstances the swine plague Schizomycetes are easily destroyed, for instance, if exposed on a bare, dry surface to the rays of light, or a free access of air; but in a suitable vehicle or nutritious substance, or protected by a porous body which keeps them moist and warm, their tenacity of life seems to be very great (*cf.* experiment with experimental pig No. 3, and the case communicated by Mr. Pendarvis). It is also a well-known fact that in the spring, particularly if a hard or dry winter has been destructive to the infectious principle, swine plague almost invariably makes its first appearance again in swine-yards which contain old straw-stacks, &c., at the edge of the timber, or in some other sheltered nook or corner where the Schizomycetes have found protection. As to a proper vehicle or nutritious substance or fluid, the Schizomycetes of swine plague do not seem to be as particular as many other kinds. Water, especially if it contains a slight admixture of organic substances, is about as suitable as anything else.

The swine-plague Schizomycetes, even in a very sick animal, or in the carcass of one that has just died, are never as numerous in the (fresh) blood as in the morbid products, the urine, the excrements, the lymph,

the pulmonal exudation, &c., and are usually found in the fresh blood taken from a vein or artery and examined immediately, only in their globular form. As I stated in my first report, and recent observations have confirmed it, the globular Schizomycetes undergo changes, develop, and, at a certain stage of their development or growth, form clusters or colonies (*zoogloea*-masses or *coccoglia*); these clusters, it seems, are formed principally in the smaller, narrower vessels, get stuck in the finer or finest capillaries, and obstruct them; then these *zoogloea* masses divide, or parts are torn off by the pressure of the blood-current, are carried a little farther, and cause new obstructions, or form emboli, a process which, it appears to me, causes most if not all the morbid changes. At any rate, in such embolic hearths, not only in the lungs, but in other tissues just as well, whole nests of partially developed (globular, double, and rod-shaped) Schizomycetes can be found. It is therefore but natural that the circulating blood contains comparatively (not positively) few Schizomycetes, because the latter are carried into, get stuck, congregate, and accumulate gradually in the capillaries already obstructed by the viscous clusters. Besides, in the emboli in the affected tissues, the Schizomycetes can always be found in great abundance in the lymphatic glands, in the kidneys, in the extravasated blood, and in the ulcerous tumors; in the kidneys, probably, because through those organs a great many Schizomycetes are eliminated. They are also thrown off or discharged through the intestines, the lungs, and the skin, and, perhaps, through the salivary glands and the mucous membrane, but that I do not know.

Most of the German investigators claim for the disease-producing Schizomycetes the same principle as the putrefaction and ferment-bacteria, that is, chemically acting or poisonous properties. Whether the swine-plague Schizomycetes act also as a poisonous substance, and not simply in a mechanical way, I do not know, because I have no proof of their chemical action, but that the many millions or billions existing in one diseased animal are able, notwithstanding their minuteness, to produce important changes by robbing the animal organism of nutritive material, and by depriving it of large quantities of oxygen, directly as well as indirectly, is very evident.

One other question may be asked, Where do the swine-plague Schizomycetes come from? This question cannot be satisfactorily answered. Only one thing is certain, they immigrate or enter from the outside, and are not developed, as has been claimed by several authors, under the influence of the disease from germs pre-existing in the normal blood. *Wherever swine-plague Schizomycetes do not find an entrance, there no swine plague will appear.*

RESULTS AND CONCLUSIONS.

These are in perfect harmony with those obtained in the fall of 1878, and in the winter and spring of 1879, and may be briefly stated as follows:

1. The most effective means of prevention that can be applied by the individual owners of swine consists, first, in promptly destroying and burying sufficiently deep and out of the way the first animal or animals that show symptoms of swine plague, if the disease is just making its appearance, and in disinfecting the premises, or, if that is difficult, in removing the herd at once to a non-infected place, or out of the reach of the infectious principle. If possible the herd should be taken to a piece of high and dry ground, free from any straw and rubbish—if recently plowed, still better—and should there receive clean food and no water

except such as is freshly drawn from a well. If this is complied with, and if all communication whatever with any diseased hogs or pigs is cut off in every respect, which is absolutely necessary, and still danger should be anticipated, for instance, if one or more animals should have become infected before the herd was removed, or a possibility of either food or water for drinking being or becoming tainted with the infectious principle should exist, the danger may be averted, or at least be very much diminished by administering three times a day in the water for drinking either some carbolic acid (about ten drops each time for every 150 pounds of live-weight), or some hyposulphite of soda (a tea spoonful for every 100 pounds of live-weight), till all danger has disappeared. Second, where swine plague has been allowed to make some progress in the herd, or where the presence of the disease is not discovered until several animals have been taken sick or have died, others have become infected, the best that can be done is to separate at once the healthy animals from the diseased and suspected ones; to place the healthy animals by themselves and the doubtful ones by themselves; to separate, disinfect, and treat the animals in the way just stated. Special care must be taken to prevent any communication, direct or indirect, between the three different parts of the herd. If one person has to do the feeding, &c., he must make it a strict rule to attend always first to the healthy animals, then to those considered as doubtful, and last to the sick ones, and must never reverse that rule, or go among the healthy hogs or pigs after he has been in the yard or pen occupied by the others. If possible each portion of the herd should have its own attendant, who should not come in contact with any of the others. The separation must be a strict one in every respect; even dogs and other animals may carry the infectious principle from the diseased animals or from the yard occupied by them to the healthy hogs and pigs. Buckets, pails, &c., which are used in feeding the sick hogs should not be used for the healthy ones, because the infectious principle may be conveyed by them from one place to another. Last but not least, it is very essential that the yard or hog-lot occupied by the healthy portion of the herd be higher than that occupied by the others. If it is lower, and especially if it is so situated that water and other liquids from the other hog-lots can flow into it, or over it, the separation is worse than useless, for then the healthy portion of the herd will surely become infected unless the ground is exceedingly dry. Third, whenever swine plague is prevailing in the neighborhood, any operation, such as ringing, marking by wounding, or cutting ears or tail, and castration and spaying particularly, must not be performed, but should be delayed until the disease has disappeared, or does not exist anywhere within a radius of two miles. If such operation should become absolutely necessary, the wounds must be dressed at least once a day with an effective disinfectant, for instance, with a solution of carbolic acid or thymol, till a healing has been effected.

2. Swine plague is very often communicated from herd to herd and from place to place by a careless, and, in some cases, even criminal contamination of running streamlets, creeks, and rivers with the excrements and other excretions of diseased hogs and pigs, and with the carcasses and parts of the carcasses of the dead animals. This source of the spreading of the disease can be stopped only by declaring such contamination of streamlets a nuisance and making the offense punishable by law. Allowing swine affected with the plague to have access to such streamlets should be considered as constituting good evidence of such a contamination, as also the throwing of dead hogs, or parts of a carcass, into such streamlets, creeks, or rivers.

3. The rendering tanks established in almost every locality in which swine plague is or has been prevailing, contribute very much, directly and indirectly, to the spreading of the disease. They contribute directly by disseminating the infectious principle wherever the tank-agents, who collect the dead hogs from the farmers, travel with their wagons; and by contaminating and infecting, in many instances at least, the waters of streamlets, creeks, and rivers with such parts of the dead hogs as are not worth rendering, but which constitute the principal seat of the morbid process. Indirectly they contribute by inducing the farmers to leave their dead animals lying around unburied, thus remaining a source of infection until the "dead-hog man" comes and takes them away. If transportation of swine that have died of the disease is prohibited by law, the numerous rendering tanks will soon disappear, and another source of infection will thus be closed.

4. The disease is spread not only by the transportation of dead hogs, but also by that of diseased ones. That such is the case becomes apparent by the fact that swine plague in its spreading not only follows the course of streamlets, creeks, and rivers, but also travels along the lines of railroads and public highways. All traffic in, and transportation of, diseased hogs and pigs, and of animals that have died of swine plague, should, therefore, be stopped; and sending diseased swine to market—a very common practice at present—should be made a criminal offense. Further, a law which would compel every owner of swine to take care of them, to confine them to his own premises, and not allow them to run at large on public highways, &c., would, if executed and complied with, do a great deal of good, and prevent a great many infections. It has happened very often that a stray hog or pig has carried the disease into a healthy herd; and, *vice versa*, it has happened also—perhaps just as often—that a hog or pig has become infected while among other swine and, coming home again, has introduced swine plague into the herd to which it belonged.

5. As to sweeping and effective measures of prevention, I would only repeat what I said in my last report. No authenticated case of a spontaneous development of swine plague has yet come to my knowledge, and the disease, I am more convinced than ever, can be stamped out, but only by adopting the most stringent measures, such as I advocated in my last report. If the stamping-out process is begun in the winter, after the fat hogs have been sold or butchered, and before the spring pigs have been born, the difficulties will not be insurmountable, and the hardships or inconveniences necessarily to be imposed upon the owners of diseased swine will not be as great as might be supposed. The best method, as stated before, would be to kill and bury or cremate, immediately, every hog or pig that shows symptoms of swine plague. Where this cannot be done, the diseased or infected herds must be isolated from all healthy animals for a period extending at least to two months after the last sick animal has died or recovered. All dead hogs or pigs must be immediately buried or burned; persons attending to sick hogs should be prohibited from going among healthy swine; infected strawstacks, &c., should be burned.

6. As to medicines for the purpose of prevention, carbolic acid given twice or three times a day in the water for drinking has proved to be of value, and has done good service, and so has hyposulphite of soda. These medicines are valuable, and have proved to be effective, especially in cases in which there is reason to suppose that the water for drinking or the food may become infected, but it is doubtful whether the disinfecting and antiseptic properties of those medicines will be sufficient

to destroy the infectious principle or its effect, if its influx is a great one, and continued by keeping healthy and diseased swine together in the same lot, yard, or pen. A strict separation is necessary, at any rate of the greatest importance, because the effect of the infectious principle, like that of an accumulative poison, seems to increase and to become more intense or violent after each new influx; in other words, the disease, as a rule, will be the more malignant, and the time of incubation or period of colonization will be the shorter the greater the amount of the infectious principle introduced. Other disinfectants, such as salicylic acid (rather doubtful) and thymol have probably a similar effect as carbolic acid, but are rather expensive, and therefore can be made use of only on a small scale.

7. Salt and ashes, sulphate of iron or copperas, sulphur, assafœtida, black antimony, lime, coal, carbonate of soda, soap, oil of turpentine, and quite a number of other similar substances, singly, and in various combinations, have been used very extensively by a large number of farmers in different parts of the State, and at different seasons of the year, but notwithstanding diligent inquiry, I have failed to learn of a solitary case in which any of those substances, or any combination of them, has produced favorable results, or in which their use has been followed by a decrease in the mortality that might not be ascribed more reasonably to other causes. Sulphate of iron especially is of no value, neither as a preventive nor as a remedy. Mr. Bassett, an intelligent farmer in Champaign County, tried it thoroughly, and has used it extensively, and lost 96 per cent. of a very nice herd of shoats. Others have met with similar results.

8. As to a treatment of the diseased animals, there can be no doubt that a good hygienic treatment—a strict separation of the diseased animals from each other, so as to prevent any further influx of the infectious principle is advisable. Swine diseased with the plague evince very often a vitiated appetite for the excrements and the urine of their companions, and as these excretions contain immense numbers of Schizomycetes, spherical and rod-shaped, and are therefore highly infectious, more and more infection or disease-producing elements will be introduced into the animal organism if that vitiated appetite is satisfied. Clean quarters and clean troughs (it is very important to clean the troughs after each meal), clean and fresh well-water to drink, clean food to eat, reasonable and adequate protection against the inclemency of the weather (against heat as well as against cold, rain, snow, &c.), and pure air to breathe will go a good way and may save many an animal.

As to a medical treatment, it would be necessary, if anything at all is to be accomplished, to subject every individual animal to a special treatment, dictated by circumstances; but as this is impossible, especially in a large herd of swine, not much can be expected from the use of medicines unless a "specific" is discovered that is simple of application. If such a specific remedy is existing, one would suppose, from the nature of the disease, it must be among the antiseptics or disinfectants. I have tried several of them, and so far have met with very poor results, as most of the animals thus treated have died, probably because the morbid changes had become irreparable. Hyposulphite of soda especially, which afterwards, in Mr. Graham's herd, proved to be very effective, even under aggravated circumstances—at least, its use was attended with very satisfactory results—and which is comparatively cheaper, and easy of application, was used extensively in three different herds, but failed to produce any visible good results, and so with all other medicines that were tried.

All the medicines, secret and otherwise, used so far—and their number is legion—have not done a particle of good, or, if they have, I have been unable to hear of it. Usually those farmers who have used the most medicine, or the greatest variety of medicines, have lost the largest number of hogs, possibly because, relying upon the medicines, they neglected all other sanitary measures. Good results, in somewhat mitigating the morbid process and improving thereby the chances of recovery, have been produced by feeding boiled, cooked, or steamed food, and also by feeding animal food. The wholesome effect of the former seems to be due to the fact that in cooked, boiled, or steamed food, if fed as soon as cold enough, no disease-producing Schizomycetes are apt to be existing, and if it is fed exclusively none are introduced through the digestive canal into the animal organism. Animal food has had in some cases a good effect, probably because it is rapidly digested, and a rapid digestion, it seems, is not favorable to an introduction of the disease-producing Schizomycetes into the animal organism by means of the digestive canal. Still, feeding animal food constitutes by no means a sure protection, because hogs fed in slaughter-houses, and hogs fed with the offal from a hotel-table (for instance, those belonging to the Doane House, in Champaign, in the fall of 1878) became affected and died of swine plague.

Very respectfully,

H. J. DETMERS, *V. S.*

CHICAGO, ILL., *February* 28, 1880.

REPORT OF DR. JAMES LAW.

SECOND SUPPLEMENTAL REPORT ON SWINE FEVER.

Hon. WILLIAM G. LE DUC,
Commissioner of Agriculture:

SIR: At the time when I made my first supplemental report, several of the experiments referred to in that paper were incomplete, while others had just been started, so that it becomes necessary to furnish a second addendum to give the final results of my observations. As the simplest mode of dealing with these supplementary facts I shall refer to them *seriatim*, beginning with those which are merely complementary of the last report.

INFECTION BY COHABITATION.

In my last report an instance of this kind was furnished, and a deduction made that the disease was most virulent when at its height, inasmuch as that the exposed pig seemed to resist the contagion from an animal in process of convalescence, but speedily (in twelve days) fell a victim when placed along with a pig in which the malady was actively advancing. In the present report (No. 1) is given the necropsy of the pig infected by such exposure. The characteristics of the disease were sufficiently well marked, for though the bowels showed little more than a catarrhal inflammation, with an excessive secretion of glairy mucus, dirty, greenish-black pigmentation and two small circular blood extravasations, yet the other organs presented distinct swine-plague lesions. Thus, there were the characteristic blotches on the skin, the petechial

SWINE PLAGUE.

Lung of Experimental heifer, showing hepatization.

A Hoen & Co Lithocaustic, Baltimore

Report Commissioner of Agriculture for 1879.

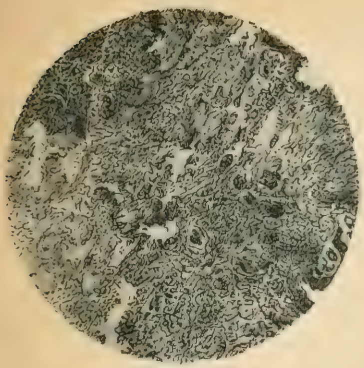
Plate II.

External surface of left lobe of lung of Mr. Morris' pig.

A Hoen & Co Lithocaustic. Baltimore.

SWINE PLAGUE.

Report Commissioner of Agriculture for 1879. Plate III.



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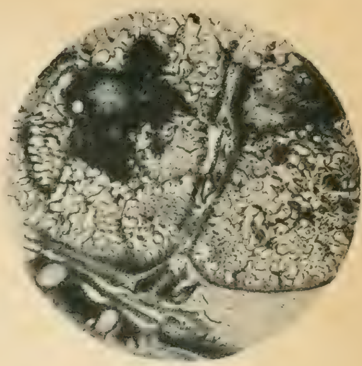

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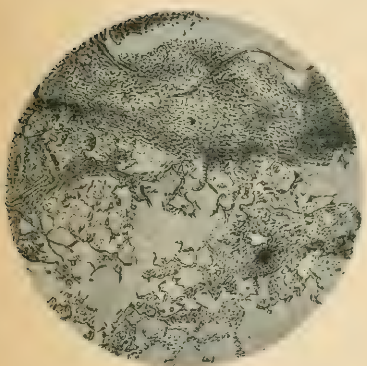

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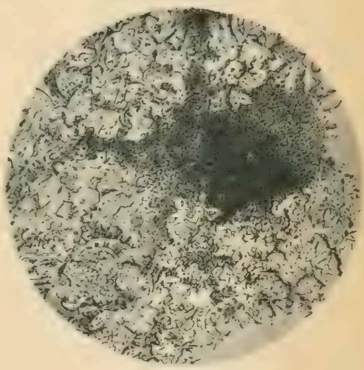

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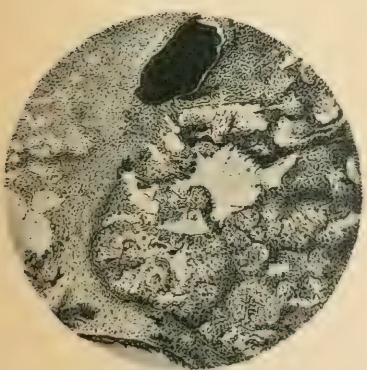

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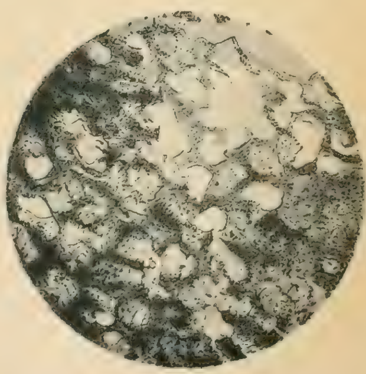
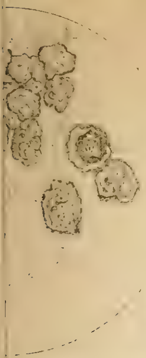


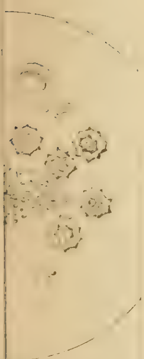
No. 6.

Nos. 1, 2, 3, 4, and 5 are thin transversal sections of lung stained in Kleinenburg's solution. No. 6, same, but not stained.

A. Hoen & Co. Lithocaustic. Baltimore



). Mucus from the br
Kay's pig, killed by
P.M., June 17, exam..
day, x 720.
corpuscles.



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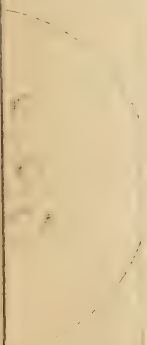

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ed from the jugularis
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SWINE PLAGUE.

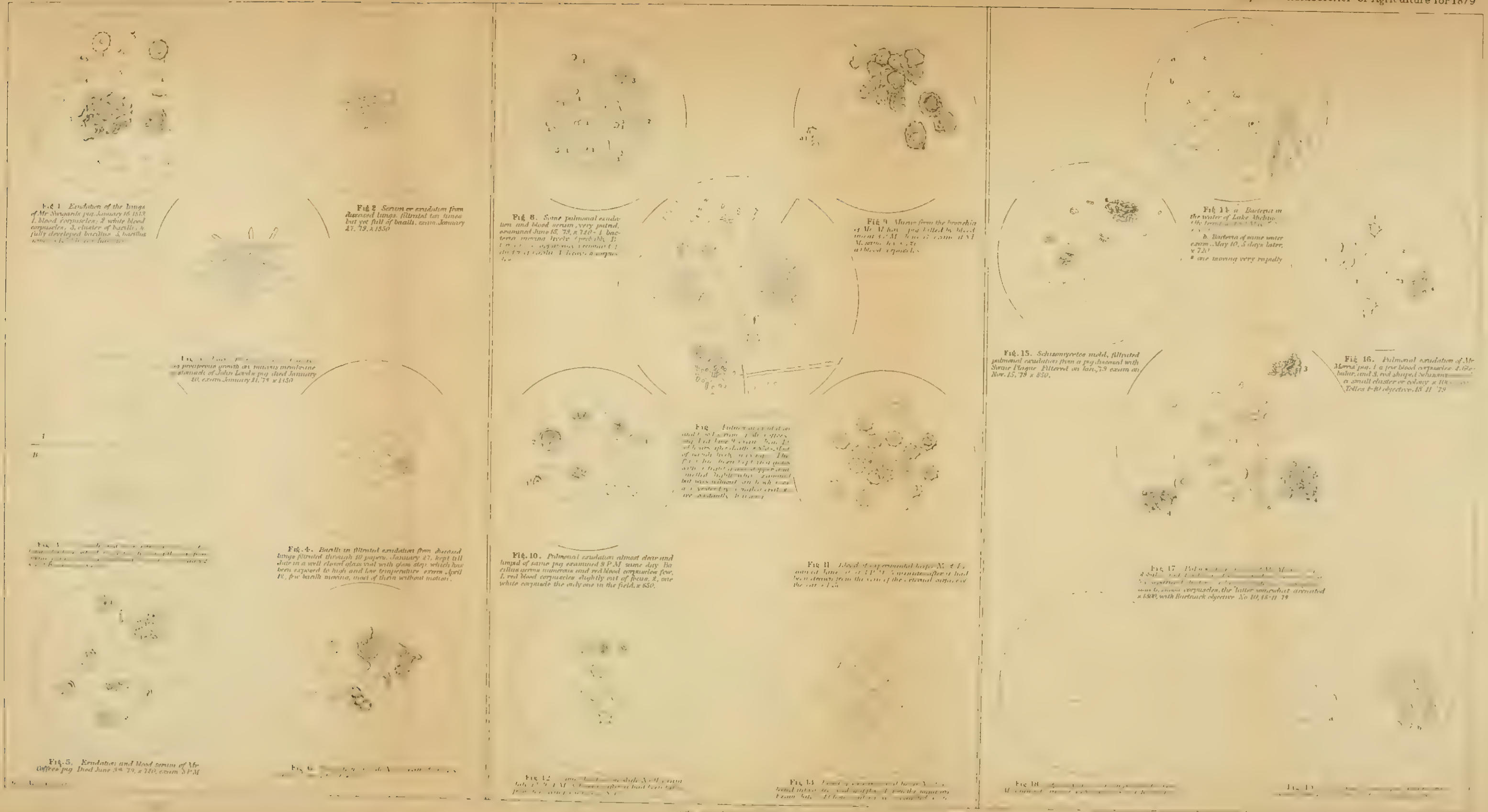


Fig. 1. Exudation of the lungs of Mr Sweganis pig, January 16 1879. 1, blood corpuscles; 2, white blood corpuscles; 3, cluster of bacilli; 4, fully developed bacillus; 5, bacillus [illegible]

Fig. 2. Serum or exudation from diseased lungs, filtrated ten times but yet full of bacilli, exam. January 27, '79, x 1350

Fig. 4. Bacilli in filtrated exudation from diseased lungs filtrated through 10 papers, January 27, kept till date in a well closed glass vial with glass stop, which has been exposed to high and low temperature, exam. April 12, few bacilli moving, most of them without motion.

Fig. 5. Exudation and blood serum of Mr Coffee's pig. Died June 3d '79, x 740, exam. 3 P.M.

Fig. 8. Some pulmonal exudation and blood serum, very putrid, examined June 15, '79, x 740. 1, bacteria moving lively [illegible]

Fig. 9. Mucus from the bronchia of Mr M[illegible] pig killed by blood [illegible]

Fig. 10. Pulmonal exudation almost clear and limpid of same pig examined 9 P.M. same day. Bacillus germs numerous and red blood corpuscles few. 1, red blood corpuscles slightly out of focus. 2, one white corpuscle the only one in the field, x 650.

Fig. 11. Blood of experimental [illegible]

Fig. 14. a. Bacteria in the water of Lake Michigan [illegible]
b. Bacteria of same water exam. May 10, 5 days later, x 720
* one moving very rapidly

Fig. 15. Schizomycetes mold, filtrated pulmonal exudation from a pig diseased with Swine Plague. Filtered on Jan. '79, exam. on Nov. 15, '79 x 850.

Fig. 16. Pulmonal exudation of Mr Morris pig. 1, a few blood corpuscles; 2, globular, and 3, rod shaped Schizomycetes [illegible] a small cluster or colony x 10[illegible] Tolles 1-10 objective, 18 11 '79

Fig. 17. [illegible] x 1300, with Hartnack objective No. 10, 18-11 '79

discolorations on the heart and in the kidneys, the deep purple patches on the liver, and above all the pigmentation or deep red congestion of the groups of lymphatic glands and all parts of the body. The significant congestion of the lungs was also present. The only remarkable feature of the case was the excessive bloody engorgement and enlargement of the spleen, which is a constant feature of malignant anthrax, but is usually found in other affections (malarial fevers, septicæmia), in which there are profound changes in the blood. While, therefore, this lesion is an unusual one, yet it is one to be expected in this disease whenever the destruction of the blood globules or material changes in the albuminoids of that fluid reach a certain point of extension. In an animal that has been exposed to the infection of the swine-plague and which presents all the other characteristic lesions, this one superadded manifestation must be accepted as only implying a more than ordinarily profound modification of the blood elements.

POST-MORTEM EXAMINATION OF INFECTED LAMB.

In my last report I gave the record of the inoculated lamb up to the end of January. (See supplementary report: pages 101 and 112.) I now add No. 2, the remainder of the record and the necropsy of the same. The intestinal irritation and catarrh as manifested by the tenderness of the anus and the mucus discharges with the feces, together with the elevated temperature and enlarged lymphatic glands, presented much in common with the affection in the pig. The marked eruption in the ears might be accepted as representing the skin lesions of the pig.

After death the more characteristic lesions were the purple mottling of the liver, kidneys, and heart, the grayish consolidation of portions of the lungs, and the deep pigmentation of the lymphatic glands in general. The nodular caseous masses scattered so profusely along the coats of the bowels in this case, and which are far from uncommon in sheep, appear to consist of diseased and overdistended mucus crypts, and cannot be held as in any way connected with the contagion of the swine fever.

The absence of acute lesions, like red congestion of the lymphatic glands, in this lamb may be partly accounted for by the mildness with which the disease manifested itself, and by the fact that nearly four weeks had passed since the last inoculation, and three weeks since the last manifestation of abnormally high temperature. That the lamb suffered from the poison may be safely assumed from the fact that the pig No. 4 sickened with the specific fever after inoculation from it.

POST-MORTEM EXAMINATION OF THE INFECTED MERINO NO. 3.

Like the lamb, this was left with an imperfect record in our last report. In this the life record is completed and the necropsy given, with results very similar to those furnished by the lamb. Here again the main changes consisted in purple mottling of the liver and heart, and the deep pigmentation of the lymphatic glands. The yellowish-brown coloration of the kidneys implied antecedent changes probably of the nature of inflammation or extravasation. The caseous rounded masses found in the bowels of the lamb were remarkable here by their absence in further corroboration of the remark that these are independent lesions resulting from pre-existing disease, and in no way connected with that now occupying our attention.

PIG SUCCESSFULLY INOCULATED FROM SHEEP AND LAMB NO. 4.

(See supplementary report, page 101.)

This experiment, referred to in the text of the last report, is now furnished *in extenso* with the necropsy of the infected pig. It will be seen that the pig was inoculated twice, at an interval of fifteen days, with the mucus from the anus of the infected sheep, and one with scabs from the ear of the lamb. Enlarged lymphatic glands were observable before the last inoculation, and six days after it there was a febrile temperature, and the more violent manifestations of the complaint.

After death the following characteristic lesions were observed: The intestines had patches of congestion, the follicles were enlarged and the rectum ulcerated; purple discolorations were present on the liver, kidneys, and heart; the lymphatic glands were enlarged and congested, of a deep red, in some cases almost black.

This evidence as to the nature of the disease was clear enough, but to substantiate it the following experiment was undertaken:

SUCCESSFUL INOCULATION FROM THE PIG INFECTED BY THE SHEEP NO. 5.

The pig designated as No. 5 in this report was inoculated with scabs from the ear and eyelids of pig No. 4, and though this caused little change of temperature, it was followed by all the other prominent symptoms of the disease. On *post-mortem* examination on the twelfth day after the inoculation, the characters of the plague were found well marked. The red and black blotches on the skin were extensive, the ears blue, the intestines extensively congested with enlarged follicles in the cæcum and colon and blood extravasations and ulcers in the rectum. Purple discolorations and petechiæ were numerous on the liver, kidneys, and heart, and finally the lymphatic glands in general were in part congested of a deep red, and in part pigmented as the result of a previous congestion.

Here, then, in the second generation of the poison from the sheep we have the symptoms as well marked and the course of the disease as rapid and severe as in its first remove from the ovine subject.

PIG SUCCESSFULLY INOCULATED FROM THE INFECTED LAMB.

In experiment No. 6 of the present report is given the record of a pig inoculated from the swelling in the axilla (near the seat of inoculation) of the lamb. The inoculation produced fever, with the general malaise, moping, peevish grunt, inappetence, and cutaneous blotches of the swine-plague. When killed, on the eleventh day, the skin presented a number of red and purple blotches, and was covered with the black unctuous exudation so frequent in this disease. The bowels contained patches of congestion, the cæcum and colon enlarged, and the follicles and the rectum ulcerated. The liver, kidneys, lungs, and heart had purple blotches. Finally the lymphatic glands in the abdomen were enlarged and congested of a deep red or black, and those in the chest and guttural region darkly pigmented. This is as unequivocal a case as those already recorded, and fully confirms our position that the virus of this disease may be transmitted through the sheep and conveyed back to the pig with active effect.

INOCULATION FROM RAT AND LAMB NO. 7.

In my last report, page 101, I reported suspicious lesions in a rat inoculated with swine-plague virus and more characteristic symptoms in a pig inoculated from this rat. In No. 7 of the present report will be found the full record of the pig in question. By a reference to this record it will be seen that without much elevation of temperature this pig showed a purple cutaneous eruption on the fifth day and enlarged glands on the twelfth, when it was inoculated with bloody mucus from the anus of the infected lamb. After this the symptoms became much more severe, and when killed, twenty-two days after, the pig showed unequivocal symptoms of the affection. Whatever may be concluded as to the result of the infection from the rat in this case, it is at least a further corroboration of the position that the inoculated sheep is infecting. To further test the susceptibility of the rodent, the following experiments were undertaken:

INOCULATIONS FROM PIG, RAT, AND LAMB.

The subject of this experiment was a female Suffolk pig presented by Cornell University, having been the smallest of the litter. It was about three months old, small for its age, and very fat and sluggish. It was first inoculated with albumen which had been charged with a drop of blood containing bacteria, from pig No. 13 (see report page 90), and had been cultivated in three succeeding portions of albumen drawn on each occasion from a fresh, newly-broken egg, through a tube that had been previously heated to redness to destroy all organic life. For fifteen days nothing more was shown than a few purple spots and patches on the rump, tail, and hocks.

The subject was again inoculated with the congested intestine of the rat which had died two days after the inoculation. The intestine had been frozen over night. For thirteen days more the same equivocal symptoms continued.

A third inoculation was now practiced, this time with bloody mucus from the anus of the lamb, diluted with a weak solution of common table-salt.

Twenty-two days after the third inoculation the pig was sacrificed, and beyond some pigmentation of the lymphatic glands presented no distinct lesions that could be held characteristic of the specific fever. In short, the animal had suffered so slightly, if at all, that it might well be set down as a case of insusceptibility. This is only what was to be expected, as in the case of all plagues and contagia a certain number of animals will successfully resist exposure and escape, though the infection is most virulent and concentrated. The number of my subjects was too small to allow of any satisfactory general estimate; but, so far as it goes, it shows one insusceptible animal in twenty-five, or at the rate of five per cent. It may, however, be questioned whether the pigmentation of the lymphatic glands did not imply a previous mild attack of the disease, and whether the apparent immunity in the later inoculations was not due to the protective influence of the previous illness.

SUCCESSFUL INOCULATION OF A RAT—NO. 9.

This subject was inoculated February 5, 1879, with virulent matter that had been preserved for seventy-eight days, closely packed in dry wheat-bran. The rat was preserved for thirteen days, and finally killed February 18, and dissected immediately after death. The guttural lym-

phatic glands were deeply congested, so as to be mottled with red. The inguinal glands had a brownish-red hue, the sublumbar lymphatic glands were enlarged and pigmented. The small intestines presented patches of congestion and redness. The right lung was in greater part red and consolidated. The liver was deeply mottled with purple, and the kidneys of a very dark red externally. Finally, the spleen was greatly enlarged and gorged with blood.

Taken all in all, these symptoms are so closely in keeping with those of swine plague that there seemed no reasonable grounds for doubting that it was really this disease. The one drawback to this conclusion is the condition of the spleen; but the enlarged and blood-gorged condition of this organ is not unknown in the pig itself, as shown in No. 1 of the present report. A second reason for not attaching undue importance to the engorged spleen, nor accepting it as indicative of malignant anthrax, is that the pig inoculated from this rat developed all the symptoms of the hog-fever, while the spleen was rather shrunken and puckered than enlarged. Had it been inoculated with the virulent products of malignant anthrax, engorgement and distension of the spleen had been inevitable.

SUCCESSFUL INOCULATION FROM THE RAT.

On February 19 a healthy pig was inoculated with the congested lymphatic glands and lungs of the above-mentioned rat, the morbid products having been inserted in a pouch under the skin.

On the sixth day there was much malaise, with redness of the skin and the appearance of the black unctuous exudation on the ears and legs. These went on increasing, and black spots and patches, ineffaceable by pressure, appeared on the inside of the thighs and hocks.

The subject was destroyed on the twentieth day and showed the usual symptoms of the disease. The stomach and bowels were congested, with glandular swellings in the large intestines, the lymphatic glands corresponding to the congested bowels were of a deep red, almost black, and elsewhere the lymphatics were enlarged and pigmented. Purple blotches appeared on the liver, heart, lungs, and air passages, while the spleen was small, rather bloodless, puckered, and shrunken.

The symptoms of the disease were, in short, as unequivocal as when inoculation was made from the sick pig direct, and, taken along with the less conclusive evidence furnished by case No. 7, may be held to prove that the rat is capable of contracting this disease and of conveying it back to the pig.

PROBABLE CONVEYANCE OF THE DISEASE BY RATS.

In my report for 1878 I expressed an apprehension of this disease being conveyed by rats, which fear is only too fully justified by the more recent developments. The danger of the conveyance of diseases by these vermin not only from pen to pen, but from farm to farm, can never be lost sight of, as rats do not by any means confine their depredations to a circumscribed locality, and are quite ready to emigrate and found a new colony if their present habitat is unproductive or closely beset by their natural enemies. Rats, therefore, that pass from one piggery to another may convey the specific poison on their surface or in their systems, and may not only leave the germs in the troughs while sharing the feed with the pig, but even inoculate it direct while gnawing the horns of its feet.

The importance of exterminating rats from the vicinity of piggeries

cannot be too strongly insisted on. Rats are probably the main source of trichinia spiralis in pigs, as the infected rat, with its muscles wasting as the result of the lodgment in their fibers of myriads of the encysted trichinia, becomes correspondingly weak and inactive, and is easily caught and devoured by the omniverous animal. If, then, we take the observation of Dr. Bellfield and Mr. Attwood as a basis, and accept as a fact that 8 per cent. of the hogs killed in Chicago are trichinous; add to this that the discovery of these worms in American hams and bacon has led to the closure of several European markets against these products; and, finally, that this specific fever of swine may be contracted and conveyed by rats, and we have cause enough for the closer supervision of the breeding of swine, and for a systematic destruction of rats wherever either trichiniasis or the swine plague has manifested itself. The swine breeders themselves should be warned against this source of disease and loss, but the sanitary authorities should follow up every case of trichiniasis and hog cholera, and see that the rats are not allowed to become active in its propagation.

INFECTION BY INOCULATION OF CULTIVATED VIRUS.

My last experiment was made with a material which might have been supposed to have been thoroughly disinfected. A little pleuritic fluid swarming with actively moving bacteria was added to some milk and boiled for five minutes. When cold, a drop or two of ammonia was added, the neck of the glass vessel plugged with cotton wool, and the whole placed in an incubator at 98° F. for two days. A second and third portion of boiled milk and ammonia were successively inoculated from the first and second, and a little of the milk with the third generation of the cultivated poison was injected under the skin of a healthy pig.

The subject suffered from illness with red and purple spots on the skin and a greasy black exudation; was killed on the twenty-first day and immediately dissected. The stomach was extensively discolored, of a dark brownish red, becoming a bright red at the margins. The small intestines were congested and showed punctiform pectichiæ, especially on the duodenum and on the ilieum near the ileo-cæcal valve. The large intestine had enlarged follicles and patches of congestion, and the lymphatic glands of the bowels were discolored a deep red. Elsewhere the lymphatic glands were either reddened or pigmented. The lungs and liver showed little change, but there were purple discolorations on the kidneys and heart.

This case was evidently one of the specific hog fever, and, unless some source of fallacy entered, seems to imply that the germs of the disease may on certain conditions resist for a time the heat of boiling water. A single experiment is, however, too narrow a basis for the support of a theory, and I shall therefore content myself with merely recording the result, and leave the matter to be made the subject of a more crucial test at some time in the future.

Perhaps the most remarkable feature of these experimental inoculations is the fact that the pigs inoculated from the infected sheep and rats appeared to take the disease in a mild form, and in all such cases it seemed probable that, had the animals not been sacrificed by the knife, a recovery might have ensued. In the case of the pigs inoculated from the sheep, one (No. 4) was twice inoculated, thirty-eight and twenty-three days before it was killed, and although the disease showed itself in an unequivocal form, yet it was not severe and did not promise a fatal result. A second (No. 7), inoculated from the lamb twenty-one days be-

fore it was sacrificed, proved more severe, but did not reach a fatal result; a third (No. 8) was inoculated twenty-two days before its death, and showed such slight symptoms and *post mortem* lesions that it might have been questioned whether it really had the disease; a fourth (No. 5), inoculated twelve days before its death, had very slight symptoms and lesions of the disease; while in a fifth (No. 6), that lived for the same length of time after inoculation, the symptoms were more severe, but there was no certain indication of a fatal result.

Of the pigs inoculated from the rat, two (Nos. 1 and 7), inoculated from the first rat, had such slight symptoms that they were afterward inoculated from the lamb, and the third (No. 10) inoculated from the second rat, twenty days before it was killed, showed moderate but distinctly marked symptoms, and was manifestly improving when it was sacrificed.

Inoculations from the infected rabbit were more redoubtable. One pig (No. 8, Add. I), inoculated twice from the rabbit and killed on the fourteenth day after the last inoculation, was suffering severely and might have died. Another (No. 9, Add. I) was so ill on the twentieth day after the inoculation that he could not have survived many hours longer.

These facts point to the most important conclusion that the poison of the swine plague, when passed through the system of the sheep or rat, becomes lessened in virulence, and usually conveys the disease back to the pig in a non-fatal form. Should this be sustained by further experiment, and should this, like some other bacteridian diseases, so affect the system that a second attack is rendered much milder or entirely prevented, it will open the way for a system of vicarious inoculation that will save our swine breeders from the yearly losses of tens of millions that now threaten the very existence of this industry. It is noticeable that the pig (No. 5) inoculated from the pig infected from the lamb, and therefore by poison the second remove from the ovine subject, though showing symptoms of the disease, did not suffer severely in the twelve days it was allowed to survive, so that the mitigation of the poison may remain for some generations after it has once passed through the sheep.

That a further inquiry in this direction promises valuable results may be further deduced from recent developments in anthrax and chicken cholera.

In February, 1878, Burdon Sanderson and William Duguid, at Brown Institution, London, inoculated guinea-pigs with the poison of the anthrax, and conveyed the disease from guinea-pig to guinea-pig for several generations of the poison. From different guinea-pigs it was inoculated back upon two yearling heifers and a six months' calf, and in all produced active disease, but in no case with a fatal result. Recovery in all cases might be said to have occurred by the fifth day. The liquids from the guinea-pigs thus inoculated on the cattle were subjected to the counter test of inoculation on other guinea-pigs, and in all cases with fatal results. To test the effect on the system the calf was reinoculated fifty-two days after the first, and the heifers nine days after the first, with the effect of producing a milder attack on the heifers, and a severe but not fatal illness in the calf.

Again, twenty-five days later, they were inoculated with anthrax poison, cultivated in grain infusions, which makes a most virulent and fatal preparation; but, though two sickened, in none did a fatal result ensue.

Dr. Greenfield, who was in charge of the Brown Institution in 1879, continued these experiments. A steer was inoculated four times in

succession with anthrax poison from the guinea-pig with steadily-decreasing results, and then a fifth time with blood from an anthrax sheep; but he survived all, and did well.

A six-months' calf was inoculated with anthrax fluids that had passed through the guinea-pig and been afterward cultivated in an albuminous fluid for four generations of the poison, and nine days later, with blood direct from the spleen of an anthrax guinea-pig; but a recovery ensued in both cases. An old emaciated and pregnant cow inoculated with the blood of an anthrax guinea pig died on the fourth day. Age, debility, and pregnancy were charged with the result. Finally, a sheep was inoculated with the anthrax poison that had been passed through the guinea-pig, and thereafter cultivated to the fourth generation in an albuminous fluid; but the result was not fatal. It should be added, that the anthrax liquids used on all these animals were tested by contemporary inoculations on guinea-pigs and mice, and invariably with fatal effect.

As a sequel to these, it should be noticed that Pasteur claims to have mitigated the poison of *chicken cholera* and the bacteridian disease by cultivation in different fluids; and to have conveyed it back to the fowl, not only without producing a fatal result, but with the effect of rendering the system of the fowl unimpressible by the same poison for the future.

The close analogy between these two diseases and the swine fever in their mode of causation by bacteria suggests very strongly a common pathology for all; and as the mode of reproduction and development of the different bacteria which respectively cause the three plagues is probably the same or closely allied, the promise is held out that the specific swine fever may be anticipated and prevented, as the above experiments imply that the other two affections can be.

Nor are the above-named observers alone in their tentative results. Wernich, Bauman, and Neucki find it highly probable that bacteria are destroyed by certain products of the putrefaction to which they themselves have given rise; so that the continued existence or propagation of a specific bacterium in an individual system is rendered difficult or impossible by the previous generation of that microphyte in the same animal body.

But at this point still another question arises. In view of the mild effects produced by inoculating the cultivated virus (Nos. 8 and 10, present report), may the poison of this disease not be mitigated by cultivating it in particular solutions, so that when inoculated on the pig it will come short of destroying life, and yet prove a protection against the ordinary fatal form of the poison? Klein's cultivations were made in the aqueous humor of the rabbit, and though he has not stated how violent were the inoculated cases, yet it would not be surprising if they proved fatal, as did our own cases of inoculation from the rabbit. My inoculations with the swine-plague virus preserved in bran produced severe symptoms and a fatal result, in keeping with the virulence of anthrax virus which had been preserved in a similar medium. In my other cases, inoculated with virulent egg-albumen (No. 8) and ammoniated milk (No. 10), the resulting disease was moderate, and did not threaten fatal result.

While, therefore, it cannot be confidently affirmed that we can at will induce a mild form of this affection which shall protect the system against a severe one, we have in the above facts a sufficient warrant and inducement to carry this experimental investigation to a certain and reliable conclusion. It remains for the experimental pathologist to

determine the exact conditions under which such immunity can be acquired, if at all, and how long the protection to the system is vouchsafed. From present appearances it seems oversanguine to expect of our legislators any sufficiently vigorous and persevering system of extinguishing our imported and indigenous animal plagues, so that it becomes the more desirable that we should bend our energies to ascertain what measures will rob the more prevalent ones of their terrible mortality, and if the plague germs must be produced and preserved in our midst, what will assure us that only the mitigated form of the poison shall be laid up, and not the deadly one, as heretofore.

JAMES LAW.

ITHACA, N. Y., *June* 10, 1880.

APPENDIX.

RECORD OF DR. LAW'S EXPERIMENTS.

Poland China pig, infected by cohabitation. (*See experiment No. 6, Addendum I.*)

EXPERIMENT No. 1.

Date.	Hour.	Temperature of body.	Remarks.
1879.		° F.	
Jan. 31	10 a.m..	103	
Feb. 1	...do	102	
2	...do	101.5	
3	...do	102	
4	...do	101.75	
5	...do	100.5	
8	9 a.m..	102.25	
9	...do	101.25	
10	...do	102	
12	...do	102	
14	.. do	101	Looking badly.
15	...do	100	
16	...do	99.75	

Post mortem examination, February 17.—*Skin:* Deep red blotches beneath the belly, inside the fore and hind legs, under the jaws, and at the entrance of one nostril.

Digestive organs: Mouth natural. Submaxillary and gutteral glands congested and pigmented.

Stomach: Contains food meal, with a little hay and an excess of yellow viscid mucus.

Small intestines: Contains much glairy, yellow mucus, with some food in the lower part of the ileum. *Ileo-cæcal* valve is pigmented of a deep dirty green beneath the mucous membrane. *Rectum* has two small circular blood extravasations.

Liver: Mottled with purple spots. Gall-bladder full of dark green viscid bile.

Spleen: Enormously enlarged (eleven inches long by two inches wide at its broadest part). Gorged with blood.

Inguinal, circumflex ileac, pelvic, sublumbar, mesenteric, and *omental lymphatic glands* pigmented.

Kidneys: Left, natural on the surface; cortical substance brownish yellow; medullary substance with numerous purple ecchymosis. Right has patches of congestion on the surface of its outer border, and otherwise bears the same lesions as the left.

Lungs: Have congested lobules partially collapsed.

Heart: Endocardium mottled of different shades, from purple to yellowish brown. Above the tricuspid valve is a considerable straw-colored exudation.

Subdorsal lymphatic glands: Deeply congested and discolored. *Prepectoral and prescapular glands* in a similar condition, and surrounded by a semi-liquid straw-colored exudation. A similar exudation is found around the guttural glands in the pericardium and around the base of the heart.

Experiment No. 2.

Long-wooled lamb. (*See No.* 11, *Addendum I, page* 112.)

Date.	Hour.	Temperature of body.	Remarks.
1879.		° F.	
Jan. 31	10 a. m..	104	Scours, passing much mucus; iliac glands enlarged.
Feb. 1	...do	104	
2	...do	104	
3	...do	103	
4	...do	104.8	
5	...do	104	A hypodermic needle brought a greenish cheesy-looking matter from the center of the axillary swelling.
6	...do	102	Increased axillary swelling.
7	...do	103.75	
8	...do	103.75	
10	...do	103	
12	...do	103.25	
14	...do	102.75	
15	...do	103.75	
16	...do	104.25	

Killed by bleeding, February 18, 1879.—*Post-mortem* examination immediately after death.

Digestive organs: Tongue sound; *stomach* sound.

Small intestines and, to a greater extent, the cæcum and colon studded with hard, spherical nodules containing a caseous material, and some of them communicating with the cavity of the intestines by a narrow orifice. *Guttural œsophagean* and *mesenteric lymphatic glands* gray from pigmentation.

Liver: Mottled with purple and yellowish spots. Bile of a bright green. *Hepatic lymphatic glands* deeply pigmented. *Spleen* natural.

Kidneys: Cortical substance slightly purple on the surface. Medullary substance of a pale yellowish white, surrounded by a purple zone. Peritoneum contained three hydatids.

Lungs have a number of lobulets of a dark-red congested appearance, but still firm and tough. There are also a number of hard nodules of a dirty grayish color on the surface of the organ. No parasites. *Bronchial lymphatic glands* pigmented.

Heart: Purple spots on the endocardium of the right and left ventricle, especially the latter.

Experiment No. 3.

Merino sheep. (*Continued from page* 112, *No.* 10, *Addendum I.*)

Date.	Hour.	Temperature of body.	Remarks.
1879.		° F.	
Jan. 31	10 a. m..	103.8	
Feb. 1	...do	102.5	
2	...do	103.75	
3	...do	102.75	
4	...do	100.5	
5	...do	103.5	
6	...do	102	
8	...do	103	
9	...do	102.5	
10	...do	102.5	
12	...do	102.75	
14	...do	103	
15	...do	102.5	
16	...do	102.75	

Merino sheep: Killed by bleeding, February 18, 1879.—*Post-mortem* examination immediately after death.

Digestive organs presented nothing abnormal. *Mesenteric lymphatic glands* deeply pigmented.

Inguinal glands deeply pigmented, especially to the medullary portion.

Liver has purplish and reddish mottling on the surface.

Gall-bladder: Partially full of a bright-green bile.

Spleen: Normal.
Kidneys: Yellowish brown in cortical portion.
Right lung: In great part congested, of a bright red color.
Right heart: Has endocardium marked with purple spots.
Left heart: Mottled extensively with spots of a dark purple.

EXPERIMENT NO. 4.

White male pig.

Date.	Hour.	Temperature of body.	Remarks.
1879.		° F	
Jan. 7	9 a. m..	102	
8	...do	100. 5	
9	...do	101	
10	...do	100. 75	
11	...do	102. 75	Inoculated with mucus from anus of sheep.
12	...do	104	
13	...do	102	
14	...do	103	
15	...do	104. 75	
16	...do	103. 3	
17	...do	102. 75	
18	...do	102. 25	
19	...do	101. 5	
20	...do	102	
21	...do	102. 5	
22	...do	102	
22	5 p. m..	102	Inoculated with scab from ear of lamb.
23	9 a. m..	101. 5	
24	...do	100. 5	Inguinal glands enlarged.
25	...do	101. 75	Inoculated with anal mucus from sheep and lamb
26	...do	99. 75	
26	4. 30 p. m	102	
27	9 a. m..	101. 75	
28	...do	102	
29	...do	103	
30	...do	102	
31	...do	103. 75	Enlarged inguinal glands; purple spots on belly.
Feb. 1	...do	104	
2	...do	103	Off feed; livid spots on teats.
3	...do	102. 5	Livid spots; enlarged glands; unctuous secretions from skin.
4	...do	102	Off feed; pink papules at hair-roots; black skin exudation, concreting in scabs.
5	...do	102. 75	
6	...do	104. 5	
8	...do	103	
9	...do	102. 25	
10	...do	102. 75	
12	...do	102. 75	
14	...do	103. 25	
15	...do	103	
16	...do	103	

White male pig: Killed by bleeding, February 17.—*Post-mortem* examination immediately after death.

Digestive apparatus: Mouth healthy. *Guttural lymphatic glands* pigmented.

Stomach: Full of food; mucous membrane slightly congested.

Small intestine: Slightly congested at isolated points.

Large intestine: Has patches of congestion and enlarged follicles, the latter especially in the colon. Rectum bears an ulcer, the scab of which is marked on the outer coat of the bowel by a liquid exudation and a congested lymphatic gland.

Duodinal lymphatic glands very black: *Mesenteric lymphatic glands* pigmented, of varying shades of gray. *Rectal lymphatic glands* blood-red.

Liver: Mottled with purple spots. Gall-bladder full of dark-green liquid bile.

Spleen: Normal in size, but with yellowish-white shrunken portions along the edges.

Kidneys: Yellowish-brown on the cortical part, but with petechial spots on the surface and internally on the medullary portion.

Lungs: Normal. *Endocardium* mottled with purple spots. Subdorsal and internal pectoral glands deeply congested.

EXPERIMENT No. 5.

White male pig.

Date.	Hour.	Temperature of body.	Remarks.
1879.		° F.	
Jan. 30	10 a. m..	102	
31	.. do	103.6	
Feb. 1	...do	102.5	
2	...do	102.5	
3	...do	104	
5	...do	103.5	Inoculated with scab from ear and eyelids of sick pig No. 4 (infected from sheep and lamb) and placed in same pen with it.
6	...do	104	
8	...do	103.5	
9	...do	102.25	
10	...do	103	
12	...do	103	
14	...do	103	
15	...do	103	
16	...do	102.75	

White male pig: Killed by bleeding, February 17.—*Post-mortem* examination at once.

Skin: Dark-red blotch inside the left fore leg extending from near the carpus to the sternum. Bright-red spots over the anterior part of the sternum and inside the hocks, on the prepuce and lower part of the scrotum. Ears slightly blue.

Digestive organs: Tongue, tonsils, and larynx sound. Guttural and submaxillary lymphatic glands pigmented of a grayish color.

Stomach: Full of food, great curvature has its mucous membrane congested.

Duodenum: Congested of a deep red. Jejunum and ileum somewhat less so. Similar patches of congestion on the ileo-cæcal valve.

Anterior mesenteric glands the seat of dark-gray pigmentation.

Colon: Congested at intervals with many enlarged follicles. Rectum presents red discoloration and ulcers, one of the latter containing a blood-clot. Rectal and colic lymphatic glands pigmented, some red with congestion.

Intestinal parasites: Small intestines contain thirty-eight ascarides, one measuring thirteen and a half inches in length.

Liver: Has purple spots and patches, especially on the right lobe. Gall bladder is full of greenish bile.

Spleen: About natural. One spot of brownish-red congestion.

Kidneys: Have purple spots on their surface extending about one line into the cortical substance.

Heart: Left ventricle has large petechiæ on its internal surface, also on the edge of the mitral valve. Right healthy.

Lungs: Posterior border of the hinder lobe of the right lung is bluish and contains lung-worms.

Mediastinal lymphatic glands: Pigmented and congested. Some perfectly black.

EXPERIMENT No. 6.

Female pig.

Date.	Hour.	Temperature of body.	Remarks.
1879.		° F.	
Jan. 30	10 a. m..	103.25	
31	...do	104	
Feb. 1	...do	104	
2	...do	104	
3	...do	104	
4	...do	103.75	
5	...do	103.5	Inoculated with dry, greenish, cheesy matter from axillary swelling of lamb.
6	...do	105	
8	9 a. m..	105	
9	...do	104.75	
10	...do	104.5	
12	...do	104.25	
14	...do	102.75	
15	...do	103	
16	...do	103.75	

Killed by bleeding February 18.—*Post-mortem* examination immediately after death.

Skin: Purple blotch on the left flank over a globular caseous mass. Under the black, unctuous cutaneous exudation red flaques appear upon the ear, also a slightly bluish tinge upon the nose.

Digestive organs: Mouth healthy. *Guttural lymphatic glands* pigmented and enlarged. Stomach moderately filled; contents very acid; considerable reddish and brownish discoloration of the mucous membrane along the great curvature.

Duodenum: Congested in its mucous folds, with thickening of the mucous membrane.

Jejunum and Ilium: Have patches of congestion and contain eight ascarides. *Cæcum* and still more the *colon* have enlarged follicles. Rectum shows congestion and one small ulcer. Cæcum contains thirteen whipworms.

Mesenteric lymphatic glands: Congested of a deep red or black and greatly enlarged. Colic lymphatic glands perfectly black. Sublumbar and inguinal glands darkly pigmented.

Liver: Has purple patches near the free border; its cut surface is yellowish brown.

Gall bladder: Full of orange-brown bile. Spleen almost normal.

Kidneys: Right has purple spots on the surface, medullary substance and papillæ. Cortical substance less pale than usual.

Lungs: Have purple spots on their surface. Subdorsal and bronchial glands pigmented.

Heart: Right side has a large loose clot and purple motled endocardium. *Left* ventricle holds a loose clot and many of its carnuæ columnæ are black throughout, as if they were but clots of blood.

EXPERIMENT No. 7.

Female pig.

Date.	Hour.	Temperature of body.	Remarks.
1879.		° F.	
Jan. 7	9 a. m...	103	
8	...do	103.5	
9	...do	103.25	
10	...do	104	
11	...do	103.75	
12	...do	102	
13	...do	102	
14	...do	101.75	Inoculated in flank with congested small intestine of rat which died two days after inoculation from sick pig. (See page 101, Addendum I.)
15	...do	101	
16	...do	102.5	
17	...do	102.5	
18	...do	100.5	
19	...do	103.25	Purple spots on teats.
20	...do	102	Purple spots on teats and belly in size from that of a pin's head and upwards.
21	...do	101.5	
22	...do	102.25	Enlarged inguinal glands.
23	...do	102	
24	.. do	102.25	Pink spots like pins' heads mostly around roots of bristles.
25	...do	101	
26	...do	101.5	Inguinal glands materially enlarged.
27	...do	101.5	Purple on teats.
28	...do	103	Injected 1 dram saline solution with bloody mucus from rectum of lamb.
29	...do	102.8	Red spots like pins' heads along the belly.
30	...do	102	
31	...do	102.5	
Feb. 1	10 a. m..	101.75	
2	...do	102.75	
3	...do	102	Purple spots beneath breast-bone; inguinal glands enlarged.
4	...do	102.9	
5	...do	102.5	Purple flaques around the seats of inoculation; pink papules around the bristles inside the thighs, and on the belly; purple spots on one ear.
6	...do	101	
8	...do	102.25	
9	...do	101.75	
10	...do	102	
12	...do	103	
14	...do	102	
15	...do	102.75	
16	...do	103.5	

Female pig killed by bleeding February 18.—*Post-mortem* examination just after death.

Skin: Ineffaceable red spots one-third of a line in diameter on the belly, teats, in-

ner sides of the thighs, forearms, and ears. Bristles are very erect and rough. Skin covered with an unctuous secretion.

Digestive organs: Mouth, normal. Right guttural lymphatic glands enlarged and pigmented. Left, normal.

Stomach: Contains little food; sour; mucous membrane on the great curvature discolored, red and dirty brown. Small intestines with patches of congestion, especially along the folds. Large intestine has enlarged follicles and patches of congestion.

Liver: Bears purple patches. Gall bladder full of orange-brown bile.

Spleen: Nearly normal. Slightly shrunken and puckered at its thick extremity.

Mesenteric, gastric, hepatic, and mesocolic glands: Darkly pigmented, and some discolored of a deep red.

Kidneys: Nearly normal.

Lungs: With a few patches mottled of a deep red.

Heart: Left side, nearly normal; right side, with purple spots of ecchymosis.

Subdorsal and bronchial lymphatic glands: Pigmented and partially reddened.

Prepectoral and prescapular glands deeply pigmented.

EXPERIMENT No. 8.

Suffolk pig.

Date.	Hour.	Temperature of body.	Remarks.
1879.		° F.	
Jan. 1	9 a. m...	101.5	
2	...do	102	Injected hypodermically ⅜ dram of inoculated albumen, 4th generation, in inoculation apparatus from blood of pig (experiment 13) which contained moving bacteria. In emptying and recharging the apparatus the liquids were drawn from a newly-broken .83 through a tube previously heated to redness.
3	...do	101.5	
4	...do	102	Purple spots on rump and tail; papules and flaques; purple patches on the hocks.
5	...do	102.5	
6	...do	102.75	
7	...do	100	
8	...do	101	
9	...do	103	
10	...do	102	Skin has many hard and brownish black scabs covering a red slightly depressed surface.
11	...do	102.5	
12	...do	102.5	
13	...do	101	
14	...do	102	
15	...do	101.75	Inoculated with congested intestine of rat which had been frozen over night.
16	...do	103.25	
17	...do	101	
18	...do	102.5	
19	...do	101	
20	...do	101.75	
21	...do	102	
22	...do	101	Has not eaten its food.
23	...do	102	
24	...do	101	Pink spots on skin; black crusts; dung fetid.
25	...do	101	
26	...do	102	Purple spots on rump and thighs.
27	...do	102	
28	...do	101	Injected 1 dram saline solution with rectal bloody mucus from lamb.
29	...do	103	Tail has red spots; is soaked with urine and feces.
30	...do	102	
31	...do	103	
Feb. 1	...do	100.5	
2	...do	100	
3	...do	100.5	
4	...do	102	
5	...do	102.5	Purple spots on ears.
6	...do	102.5	
8	...do	102.75	
9	...do	102	
10	...do	102.5	
12	...do	102	
14	...do	102	
15	...do	102.75	
16	...do	103.25	

Suffolk pig killed by bleeding February 18.

Tongue, especially in its posterior portion, furred of a brown color.

Stomach and intestines: Bore little evidence of change.

Lymphatic glands: Pigmented.

Liver: Discolored purple patches, and, towards the margin, yellowish staining. Bile, moderate in quantity, orange brown.

Spleen: Small—a little puckered at the edges.

Kidneys: Very pale; firm and resistant, as if they had undergone fibrous degeneration.

EXPERIMENT No. 9.

Rat killed February 18, 1879.—*Post-mortem* examination immediately after death.

Guttural glands: Mottled with red and dark lines. Inguinal glands of a brownish red.

Right lung: Firm and gorged with blood. Left lung nearly natural. Liver deeply mottled with purple.

Spleen: Excessively large and gorged with blood.

Kidneys: Cortical substance of a very dark red; medullary substance, pale.

Sublumbar lymphatic glands: Enlarged and pigmented.

EXPERIMENT No. 10.

White male pig.

Date.	Hour.	Temperature of body.	Remarks.
1879.		°F.	
Feb. 3	9 a.m...	103.75	
4	...do	103.75	
5	...do	103.5	
6	...do	103.5	
7	...do	102	
8	...do	104	
9	...do	104.25	
10	...do	104	
11	...do	103.75	
12	...do	103.25	
13	...do	103.25	
14	...do	103	
15	...do	102.75	
16	...do	102.5	
17	...do	102.25	
19	...do	....	Inoculated to-day with the congested and reddened lymphatic glands and congested lungs of a rat (No. 9) which showed lesions corresponding to those of the swine fever. The infecting matters were inserted in a pouch formed under the true skin.
20	...do	102.5	
21	...do	102.75	
22	...do	102.5	
23	...do	102.75	
24	...do	102.75	
25	...do	103	Is very uneasy. Molasses-like exudation on ears and legs.
26	...do	103.25	
27	...do	103.50	
28	...do	103.75	Exudation increased and extended over nearly the whole body.
Mar. 1	...do	103.25	
2	...do	102.75	
4	...do	102.5	
6	...do	102.25	
7	...do	102.25	Exudation drying up.
8	...do	102	
9	...do	102.25	Shows much uneasiness.
10	...do	102	
11	...do	102.25	

Killed by bleeding March 11.—*Post-mortem* examination immediately after death.

Skin: Inside both thighs extending down to the hocks are discolored spots and patches, not effaceable by pressure. The molasses-like exudation on the skin is nearly dry on the body, but still soft and unctuous on the legs.

Digestive organs: Tongue healthy. Guttural lymphatic glands enlarged and pigmented.

Stomach: Has its mucous membrane mottled of a dark-purplish brown on its great curvature.

Duodenum: Slightly congested in its upper portion. Remainder of the small intestines present patches of slight inflammation. Ilio-cæcal valve normal.

Large intestines: Present small globular elevations like enlarged solitary glands. These are especially abundant in the colon.

The duodenal lymphatic glands: Of a deep red, almost black. Mesenteric lymphatic glands enlarged and deeply pigmented. Sublumbar lymphatic glands and the inguinal are similarly enlarged and pigmented.

Spleen: Normal, except that it is very firm and puckered along its border.

Liver: Firm. Patches of purple discoloration are seen, especially at the borders. Gall bladder full; bile of a bright-yellowish green.

Kidneys: Nearly normal. Cortical substance a little pale.

Urinary bladder: Full. Density of urine 1026.

Heart: Empty. Endocardium of left ventricle with numerous dark petechial spots. Those are less numerous on the right ventricle, but of a deep purple color.

Lungs: Present petechial spots on the pleuræ and bronchi.

Parasites: Five ascarides in small intestines; one hairheaded worm in cæcum.

EXPERIMENT No. 11.

White female pig.

Date.	Hour.	Temperature of body.	Remarks.
1879.		° F.	
Feb. 3	9 a. m ...	103.75	
4	...do	103.75	
5	...do	103	
6	...do	102.5	
7	...do	103.5	
8	...do	103.75	
9	...do	102.75	
10	...do	103	Has been in *rut* for several days.
11	...do	103.75	
12	...do	103	
13	...do	102.5	
14	...do	102.75	
15	...do	102.5	
16	...do	102.75	
17	...do	102.5	
18	...do	....	
19	...do	....	Inoculated hypodermically with a solution of milk and pleuritic effusion of sick pig (both boiled) with ammonia, cultivated in isolation apparatus to the third generation.
20	...do	102.25	
21	...do	102.25	
22	...do	102.5	
23	...do	102.75	
24	...do	102.5	
25	...do	102.75	
26	...do	103	
27	...do	103.25	A little exudation on the ears.
28	...do	103.5	
Mar. 1	...do	103.5	Is very uneasy. Peevish grunt.
2	...do	103.25	
3	...do	....	
4	...do	103.25	
5	...do	....	
6	...do	103	
7	...do	103.5	
8	...do	103.5	
9	...do	103.25	
10	...do	103.25	
11	...do	103.25	
12	...do	....	Killed by bleeding.

Post-mortem examination immediately after death.

Skin: A few purple discolorations on the inner side of the hocks. The molasses-like exudation has dried up into a black incrustation.

Digestive organs: Mouth and connections normal.

Guttural lymphatic glands: Slightly pigmented.

Stomach: Has several extensive dark-reddish patches on the mucous membrane covering the great curvature, shading off with bright red at the margins.

Duodenum: Congested along the margins of the folds of mucous membrane with patches of bright-red punctiform petechiæ.

Jejunum and ileum: Congested along the folds of mucous membrane, especially in the middle part of its course. Near the ilio-cæcal valve are bright-red punctiform petechiæ.

Duodenal lymphatic glands: Of a dark-red hue, almost black. *Anterior mesenteric* glands are deeply pigmented, and in many cases of a deep red.

Large intestine: Has follicles enlarged. These are especially numerous in the colon. The rectum bears patches of congestion and the lymphatic glands adjacent are of a deep red.

Spleen: Small and firm, ridged or puckered at its free border. Not gorged with blood.

Liver: Firm, nearly normal. Gall bladder filled with a bright, yellowish-green bile.

Kidneys: Nearly healthy. Medullary substance a little more highly colored than natural.

Lungs: Normal. Contains two lung worms.

Prepectoral lymphatic glands: Slightly pigmented.

Right inguinal glands: Of a deep red. Left the seat of grayish pigmentation.

Heart: Left ventricle deeply discolored internally by ineffaceable deep purple and crimson stains. Right ventricle normal. Right auricle contains a large clot.

Intestinal parasites: One ascaris in jejunum; four tricocephali in cæcum.

CONTAGIOUS PLEURO-PNEUMONIA OR LUNG-PLAGUE OF CATTLE.

Prof. JAMES LAW, V. S., of Cornell University, New York, has issued a valuable work of about one hundred pages, entitled "The lung-plague of cattle—contagious pleuro-pneumonia." This work is all the more valuable from the recent experience of Dr. Law in the treatment of this disease, for it will be remembered by many of the readers of this brief review that he was last spring appointed by the governor of New York to act as chief of a commission of veterinarians to assist the State authorities in devising and carrying out such measures as it was hoped would result in the complete suppression of this deadly malady among the cattle of that State. He states many facts connected with the history of the disease in this country not heretofore generally known, and also corrects some errors and misapprehensions touching the disease itself which English veterinarians have fallen into. He says that the name of the disease (*pleuro-pneumonia*) has been largely misapprehended by the medical mind, and that there is no proof that the malady, like other inflammations of the organs within the chest, is caused by exposure, inclement weather, changes of climate or season, imperfect ventilation, &c. Other names have been, at different times, employed; for instance, *Peripneumonia*, *Peripneumonia pecorum enzootica* or *epizootica*, *Peripneumonia exudativa enzootica* or *contagiosa*, *Peripneumonia pecorum epizootica typhosa*, *Pleuro-pneumonia interlobularis exudativa*, *Pneumonia catarrhalis gastrica asthenica*, *Pleuritis rheumatica-exudativa*. But Dr. Law regards all of these terms as objectionable, and says if the term *contagious* (*contagiosa*) be added to any of these definitions it only removes the difficulty a short step, "for the physician still concludes that the affection is due to local or general causes, and that if it arises in one animal under such circumstances it may in one million, subject to the same conditions; that its general prevalence, at any time or place, may be altogether due to the environment, and that the doctrine of contagion is either founded on insufficient data or true only in a restricted sense and entirely subsidiary to the generally acting causes. But the malady, as known to veterinarians of to-day, is always and only the result of contagion or infection." Therefore, a name better adapted to set forth the character of the disease without the risk of misleading should be chosen, and for this reason Dr. Law has adopted that of *contagious lung-plague of cattle*, the new counterpart of the *Lungenseuche*, by which it has long been known in Germany. He regards the old term, *pulmonary murrain*, as equally good. The German *Lungenseuche* is especially apposite, the real meaning being *lung contagion*, which conveys the idea of transmission by contagion only. He therefore gives, as a definition of the malady, a specific contagious disease peculiar to cattle, and manifested by a long period of incubation (ten days to three months) by a slow, insidious onset, by a low type of fever, and by the occurrence of inflammation in the air passages, lungs, and their coverings, with an extensive exudation into lungs and pleuræ.

After reciting the history of the malady in the Old World, in which

the statement is made that Great Britain alone has lost not less than $10,000,000 per annum by the ravages of the disease since the year 1842, the following brief history of its invasion and continous existence in this country is given:

Into Brooklyn, Long Island (New York), it was introduced in 1843 in the system of a ship cow, purchased by Peter Dunn from the captain of an English vessel. From Dunn's herd it spread to others adjacent and speedily infected the whole west end of the island, as will be noticed later at greater length.

Into Massachusetts the plague was introduced on the 23d of July, 1859, in the bodies of four Dutch cows, imported by Winthrop W. Chenery, of Belmont, near Boston. These cows were procured from Purmerend and the Beemster, and were kept in stables for several days at the port of Rotterdam, an infected city, before being put on board the vessel. They were shipped April 6, passed forty-seven days at sea, and were ill during the last twenty days, one of the number having been unable to stand. On landing, two were able to walk to the farm, while the other two had to be carried in wagons. The worst cow was killed May 31, and the second died June 2; the third did well till June 20, when she was severely attacked and died in ten days; the fourth recovered. On August 20 another cow, imported in 1852, sickened and died in a few days, and others followed in rapid succession. In the first week of September, Mr. Chenery isolated his herd, and declined all offers to purchase, being now convinced that he was dealing with the *bovine lung-plague* of Europe.

Unfortunately, on June 23, he had sold three calves to Curtis Stoddard, of North Brookfield, Worcester County, one of which was noticed to be sick on the way to Curtis' farm. Several days later Leonard Stoddard (father of Curtis) took this calf to his farm to cure it, and kept it in his barn with forty cattle for four days, when he returned it to his son. It died August 20. Curtis Stoddard lost no more until November 1, when he sold eleven young cattle to as many different purchasers, and wherever these went the disease was developed. In one case more than 200 cattle were infected by one of these Stoddard heifers. Of the nine cattle which he retained seven were killed and found to be badly diseased.

An ox of L. Stoddard's sickened two weeks after he had returned the diseased calf to his son, and soon died. Two weeks later a second was taken sick and died; then a dozen in rapid succession. From this herd were affected those of the following: Messrs. Needham, Woods, Olmsted, and Huntingdon. Olmsted sold a yoke of oxen to Deane, who lent them to assist with twenty-three yoke of cattle in removing a building in North Brookfield. These belonged to eleven different herds, all of which were thereby infected.

This will suffice to show how the disease was disseminated. In the next four years it was found in herds in the following towns: Milton, Dorchester, Quincy, Lincoln, Ashby, Roxborough, Lexington, Waltham, Hingham, East Marshfield, Sherborn, Dover, Halliston, Ashland, Natick, Northborough, Chelmsford, Dedham, and Nahant, and on Deer Island.

By the spring of 1860 the State had been aroused to its danger, and in April an act was passed "to provide for the extirpation of the disease called pleuro-pneumonia among cattle," which empowered the commissioners to kill all cattle in herds where the disease was known or suspected to exist. With various intervals this and succeeding commissions were kept in existence for six years, and the last remnants of the plague having been extinguished, the last resigned definitely in 1866. The records show that 1,164 cattle were slaughtered by orders of the commissioners, in addition to others disposed of by the selectmen of the different towns in 1863, when the commission was temporarily suspended. The money disbursed by the State was $67,511.07, and by the infected towns $10,000, making a grand total of $77,511.07, in addition to all losses by deaths from the plague, depreciation, &c. Dr. E. F. Thayer, Newtown, was the professional commissioner who brought this work to a successful end.

An importation into New Jersey in 1847 is recorded, to check which the importer, Mr. Richardson, is said to have slaughtered his whole herd, valued at $10,000, for the good of the State. Unfortunately, all New Jersey men were not so public spirited, and subsequently importations from New York and mayhap also from Europe have since spread this pestilence widely over the State. From New Jersey it spread to Pennsylvania and Delaware, and thence to Maryland, District of Columbia, and Virginia, in all of which it still prevails.

Of the progress of the disease southward from New York the records are somewhat imperfect, yet sufficient to show a steady advance. Robert Jennings records its existence in Camden and Gloucester Counties, New Jersey, in 1859, and its introduction into Philadelphia in 1860. It spread to "The Neck," in the southern part of the county, killing from 30 to 50 per cent. of infected herds, and spread in 1861 into Delaware and into Burlington County, New Jersey. In 1863 Mr. Martin Goldsborough assured Pro-

fessor Gamgee of the extensive prevalence of the disease in Maryland, infection having been introduced by cattle from the Philadelphia market. The professor personally traced the disease in New Jersey, Pennsylvania, Maryland, District of Columbia, and Virginia, and makes the following assertions:

"That the lung plague in cattle exists on Long Island, where it has prevailed for many years; that it is not uncommon in New Jersey; has at various times existed in New York State; continues to be very prevalent in several counties of Pennsylvania, especially in Delaware and Bucks; has injured the farmers of Maryland, the dairymen around Washington, D. C., and has penetrated into Virginia."

He adds a table compiled by Mr. G. Reid, Ingleside farm, Washington, D. C., showing that in an average of 471 cows, kept in Washington and vicinity, 198 had died of lung plague since its introduction; 39 head perished in 1868 and 16 in 1869, up to date of report.

More recently illustrations of the existence of the disease in these States have been frequent, and among comparatively recent cases the author has been consulted concerning a high class Jersey herd near Burlington, N. J., in 1877, and a herd of imported Ayrshires in Staten Island later in the same year.

In 1878, the town of Clinton, N. J., was invaded, the infection coming through a cow that had strayed for some days in New York City. This was alleged to be an Ohio cow, but had strayed long enough in New York to have contracted the affection.

After showing that the disease is a purely contagious malady, and cannot arise *spontaneously*, Dr. Law gives the following brief history of the introduction, progress, and continual presence of the affection since its introduction among the cattle in and near the city of New York.

From different old residents (including Wm. Geddes, of Brooklyn, and Hugh T. Meakim, of Flushing) who were in the milk business in Brooklyn at the time of the importation, the following facts have been obtained:

The first cow was introduced from England, on the ship Washington, in 1843, and was purchased by Peter Dunn, a milkman, who kept his cows in a stable near South Ferry. This cow soon sickened and died, and infected the rest of his cows. From this the disease was speedily conveyed into the great distillery stables of John D. Minton, at the foot of Fourth street, and into the Skillman-street stables, Brooklyn, through which my informant, Fletcher, showed the Massachusetts commission in 1862. In this long period of nineteen years, the plague had prevailed uninterruptedly in the Skillman-street stables, and the commissioner reported that they "found some sick with the acute disease," and having killed and examined one in the last stages of the affection, stated that it showed a typical case of the same malady which existed in Massachusetts.

As dealers found it profitable to purchase cheap cows out of infected herds, and retail them at a round price, the malady was soon spread over Brooklyn and New York City. One or two cases will enable us to trace one unbroken chain of infection down to the present time.

In 1849, William Meakin, of Bushwick, Long Island (New York), kept a large dairy, and employed a man with a yoke of oxen in drawing grain from the New York and Brooklyn distilleries. A milkman on the way, who had lung fever in his herd, persuaded the man to use his oxen in drawing a dead cow out of his stable. Soon after the oxen sickened and died; and the disease extending to his dairy cows, Mr. Meakim lost forty head in the short space of three months. The stables having thus become infected, Mr. Meakim continued to lose from six to ten cows yearly for the succeeding twenty years, or as long as he kept in the milk business. This, which is but one instance out of a hundred, covers fifteen years of the plague in the Skillman stables, and brings the record down to 1869. It will be observed that this was the first occurrence of any such sickness in Mr. Meakim's herd; it commenced, not among the cows cooped up in hot buildings and heavily fed on swill, but in the oxen that were almost constantly in the open air, but which had been brought in contact with a dead and infected cow; the infection of the cows followed, and for twenty long years no fresh cow could be brought into these stables with impunity.

Dr. Bothgate, Fordham avenue and Seventeenth street, New York, informed us that twenty years ago (1859) his father kept a herd of Jerseys, which contracted the disease by exposure to sick animals, and that all efforts to get rid of it failed, until when, several years later, the barns were burned down. The devouring element secured what the skill of the owner had failed to accomplish—a thorough disinfection.

For some time so prevalent was the disease that Dr. Bothgate did not dare to turn his cattle out in the fields, lest they should be infected by contact with cattle over the fence. Since the period of the infection of his own herd, he knows that the pestilence

has been constantly in many of the dairies around him. This bridges over the time from the Skillman-street and Meakim cases down to the present day.

Twenty years ago (1859) Mr. Benjamin Albertson, Queens, Queens County, Long Island (New York), purchased four cows out of a Herkimer-County herd which had got belated and had been kept over night in a stable in Sixth street, New York, where the cattle market then was. These cows sickened with lung fever and infected his large herd of 100 head, 25 of which died in rapid succession and 19 more slowly. He was left with but 60 head out of a herd, after the purchase of the four, of 104 animals, and honorably declined to sell the survivors at high prices to his unsuspecting neighbors, but sold a number at half price to a Brooklyn milkman, who already had the disease in his herd and knew all the circumstances.

Twelve years ago (1867) Lawrence Ansert, Broadway and Ridge Street, Astoria, (New York), bought of a dealer two cows, which soon after sickened and died, and infected the remainder of his herd of 18. Eight of them died of the disease, and he fattened and killed the remaining ten, and began anew with fresh premises and stock. He has lost none since.

The next case, like the last, affords a most instructive contrast to the first two, as showing how the disease may be permanently eradicated by proper seclusion. In 1872, Frank Devine, of Old Farm-House Hotel, West Chester, purchased from a dealer a cow which soon sickened and died. The disease extended to the rest of his herd, and in seven months he lost thirty-six cows. He appreciated the danger of contagion, and began again with new stock, keeping them rigidly apart from the infected beasts and premises, and from that time onward avoided all dealers and bred his own stock, with the happy result that in the last six years he had not had a single case of lung fever in his herd.

The virulence and infectious nature of the disease does not seem to have been lessened by its transplantation to this country. Many instances are given which show conclusively that it is equally as fatal today in those localities in the United States in which it exists as it is in its home in the far east, or in those nations of Europe which it has invaded. Speaking of the contagious and infectious nature of the malady, Dr. Law says:

No one who has studied the plague in Europe can truthfully claim that it is less infectious here than in the Old World. What misleads many is, that during the cooler season many of the cases assume a sub-acute type, and others subside into a chronic form with a mass of infecting material (dead lung) encysted in the chest, but unattended by acute symptoms. But this feature of the disease renders it incomparably more insidious and dangerous than in countries where the symptoms are so much more severe, that even the owners are roused at once to measures of prevention. In moderating the violence of its action, the disease does not part with its infecting qualities, but only diffuses them the more subtilely in proportion as its true nature is liable to be overlooked. A main reason why unobservant people fail at first sight to see that the lung fever is contagious is, that the seeds lie so long dormant in the system. A beast purchased in October passes a bad winter, and dies in February, after having infected several others. She has had a *long period of incubation*, and when the disease supervenes actively, she has passed through a chronic form of illness, so that when others sicken, people fail to connect the new cases with the infected purchase. Then, again, in an ordinary herd of 10 or 20 head the deaths do not follow in rapid succession, but at intervals of a fortnight, a month, or even more, and those unacquainted with the nature of the disease suppose that it cannot be infectious, or all would be prostrated at once.

The disease may be communicated by immediate contact, through the atmosphere for some considerable distance, by the inhalation of pulmonary exudation when placed in the nostrils, from impregnated clothing of attendants, through infected buildings, infected manure, infected pastures, infected fodder, &c. Healthy cattle have been contaminated after being lodged in stables that were occupied by diseased ones three or four months previously. Hay spoiled by sick cattle has induced the disease after a long period, and pastures grazed upon three months before have infected healthy stock. The flesh of diseased animals has also conveyed the malady; and it is recorded by Fleming that the contagion from cattle buried in the ground infected others 50 or 60 feet distant.

There seems to be much difference of opinion with regard to the power of the virus to resist ordinary destructive influences. Under ordinary circumstances, it will be preserved longest where it has been dried up and covered from the free access of the air. In close stables and buildings having rotten wood-work, or deep dust-filled cracks in the masonry, and in those with a closed space beneath a wooden floor, it clings with the greatest tenacity. Again, in buildings which contain piles of lumber, litter, hay, fodder, or clothing, the virus is covered up, secreted, and preserved for a much longer period than if left quite empty. In such cases it is preserved as it is in woolen or other textile fabrics when carried from place to place in the clothing of human beings. As carried through the air the distance at which the virus retains its infecting properties varies much with varying conditions. Dr. Law states that he has seen a sick herd separated from a healthy one by not more than fifteen yards and a moderately close board fence of 7 feet high, and in the absence of all intercommunication of attendants, the exposed herd kept perfectly sound for six months in succession. At other times infection will take place at much greater distances without any known means of conveyance on solid objects. Röll quotes 50 to 100 feet, while others claim to have known infection transmitted a distance of from 200 to 300 feet. But the author questions whether, in such cases, the virus had not been dried up on light objects, like feathers, paper, straw, or hay, which could be borne on the wind.

Because the lesions are concentrated in the lungs, and begin with cloudiness and swelling of the smaller air tubes and surrounding connective tissues, the presumption is favored that the virus is usually taken in with the air breathed. Its progress and the results of all attempts at inoculation would seem to confirm this. The exudation into the interlobular tissue, the congestion of the lung tissue itself, and the implication of the lung covering, are regarded as secondary phenomena, or, in other words, the disease begins where the inspired air must lodge the germs. The inoculation of the virulent lung products on distant parts of the body transfers the seat of the disease to the point inoculated, and in such cases the lesions of the lungs are not observed, or at least are not greatly marked.

A diseased animal is more likely to infect a healthy one at that period when the fever runs highest and the lung is being loaded with the morbid exudation. Proof appears to be wanting as to the infecting nature of the affection during the incubation stage, but it must not be inferred that with the subsidence of the fever the danger is removed. It is a matter of frequent observation that animals which have passed through the fever, and are again thriving well and giving a free supply of milk, and to ordinary observers appear in perfect health, retain the power of transmitting the disease to others. This may continue for three, six, nine, twelve, or, according to some, even fifteen months after all signs of acute illness have disappeared.

The number of animals infected by contact or exposure to the contagion is somewhat irregular, as is also the virulence and fatality of the disease. The French commission of 1849 found that of 20 healthy animals exposed to infection 16 contracted the disease, 10 of them severely. Dr. Lindley gives examples from his South African experience in which whole herds of 80, 130, and even of several hundred died without exception, showing that in warm climates the mortality is greatest. Dr. Law found the disease much more virulent and fatal during the hot summer months in New York, and says that during the winter season it is far less violent in its manifestations, and a great number of animals resist it.

Lung plague (pleuro-pneumonia) confines its ravages entirely to the bovine genus, and no race, breed, or age is exempt from its attacks. Sex gives no immunity; bulls suffer as much as cows; and oxen and calves, if equally exposed, furnish no fewer victims than bulls and cows.

As in rinderpest, measles, scarlatina, and the different forms of variola, an animal once afflicted with lung plague is usually exempt or impervious to a second attack. Only occasional instances are given where an animal has suffered from a second attack. The losses caused by the plague ranges all the way from 2 to 63 per cent. of all the animals in the country or locality in which it prevails, the losses varying according to climate, surroundings, condition of stock, &c.

The period of latency, that is, the time that elapses between the receiving of the germs into the system and the manifestation of the first symptoms of the disease, varies greatly. Veterinarians differ as to their experience and statements, and set this period at from five days to three months. Dr. Law has seen cases in which cattle have passed three or four months after the purchase in poor health, yet without cough or any other diagnostic symptom, and at the end of that time have shown all the symptoms of the lung plague. It is this long period of latency that renders the disease so dangerous. An infected animal may be carried half way round the world before the symptoms of the malady become sufficiently violent to attract attention, and yet all this time it may have been scattering the seeds of the disease far and wide. The average period in inoculated cases is nine days, though it may appear as early as the fifth, or it may be delayed till the thirtieth or fortieth day. In the experimental transmission of the disease by cohabitation, under the French commission, a cough (the earliest symptom) appeared from the sixth to the thirty-second day, and sometimes continued for months, though no acute disease supervened. Hot climates and seasons abridge the period of latency, as the disease has been found to develop more rapidly in summer than in winter, and in the South than in the North. A febrile condition of the system also favors its rapid development. Of the symptoms of the disease, Dr. Law says:

These vary in different countries, latitudes, seasons, altitudes, races of animals, and individuals. They are, *cœteris paribus*, more severe in hot latitudes, countries, and seasons, than in the cold; in the higher altitudes they are milder than on the plains; in certain small or dwarfed animals, with a spare habit of body, like Brittanies, they appear to be less violent than in the large, phlegmatic, heavy-milking, or obese short-horn Ayrshires and Dutch. A newly-infected race of cattle in a newly-infected country suffer much more severely than those of a land where the plague has prevailed for ages; and finally certain individuals, without any appreciable cause, have the disease in a much more violent form than others which stand by them in precisely the same conditions.

Sometimes the disease shows itself abruptly with great violence and without any appreciable premonitory symptoms, resembling in this the most acute type of ordinary broncho-pneumonia. This, however, is mostly in connection with some actively exciting cause, such as exposure to inclement weather, parturition, overstocking with milk, heat, &c.

Far more commonly the symptoms come on most insidiously, and for a time are the opposite of alarming. For some days, and quite frequently for a fortnight, a month or more, a slight cough is heard at rare intervals. It may be heard only when the animal first rises, when it leaves the stable, or when it drinks cold water, and hence attracts little or no attention. The cough is usually small, weak, short and husky, but somewhat painful and attended by some arching of the back, an extension of the head upon the neck, and protrusion of the tongue. This may continue for weeks without any noticeable deviation from the natural temperature, pulse, or breathing, and without any impairment of appetite, rumination, or coat. The lungs are as resonant to percussion as in health, and auscultation detects slight changes only, perhaps an unduly loud blowing sound behind the middle of the shoulder, or more commonly an occasional slight mucus rattle, or a transient wheeze. In some cases the disease

never advances further, and its true nature is to be recognized only by the fact that it shows itself in an infected herd or on infected premises, and that the victim proves dangerously infecting to healthly animals in uninfected localities. It may be likened to those mild cases of scarlatina which are represented by sore throat only, or to the modified variola known as chicken-pox.

In the majority of cases, however, the disease advances a step further. The animal becomes somewhat dull, more sluggish than natural, does not keep constantly with the herd, but may be found lying alone; breathes more quickly (20 to 30 times per minute in place of 10 to 15); retracts the margins of the nostrils more than formerly; the hair, especially along the neck, shoulders, and back, stands erect and dry; the muzzle has intervals of dryness, and the milk is diminished. The eye loses somewhat of its prominence and luster; the eyelids and ears droop slightly, and the roots of the horns and ears and the limbs are hot or alternatively hot and cold. By this time the temperature is usually raised from 103° F., in the slightest or most tardy cases, to 105° and upward to 108° in the more acute and severe. Auscultation and percussion also now reveal decided changes in the lung tissue.

The ear applied over the diseased portions detects in some cases a diminution of the natural soft-breathing murmur, or it may be a fine crepitation, which has been likened to the noise produced by rubbing a tuft of hair between finger and thumb close to the ear. Where this exists it is usually only at the margin of the diseased area, while in the center the natural soft murmur is entirely lost. In other cases a loud blowing sound is heard over the diseased lung, which, though itself impervious to air and producing no respiratory murmur, is in its firm, solid condition a better conductor of sound and conveys to the ear the noise produced in the larger air-tubes.

Percussion is effected by a series of taps of varying force delivered with the tips of the fingers of the right hand on the back of the middle finger of the left firmly pressed on the side of the chest. Over all parts of the healthy lung this draws out a clear resonance, but over the diseased portions the sound elicited is dull, as if the percussion were made over the solid muscles of the neck or thigh. All gradations are met with as the lung is more or less consolidated, and conclusions are to be drawn accordingly.

In other cases we hear on auscultation the loud, harsh, rasping sound of bronchitis, with dry, thickened, and rigid membranes of the air-tubes, or the soft, coarse, mucus rattle of the same disease when there is abundant liquid exudation, and the bursting of bubbles in the air passages. In others there is a low, soft, rubbing sound, usually in jerks, when the chest is being filled with or emptied of air. This is the friction between the dry, inflamed membrane covering the lungs and that covering the side of the chest, and is heard at an early stage of the disease, but neither at its earliest nor its latest stage. Later there may be dullness on percussion up to a given level on one or both sides of the chest, implying accumulations of liquid in the cavity, or there is a superficial dullness on percussion, and muffling of the natural breathing sound with a very slight, sometimes almost inaudible, creaking, due to the existence of false membranes (solidified exudations) on the surface of the lung or connecting it to the inner side of the ribs. This is often mistaken for a mucous rattle that can no longer take place in a consolidated lung in which there can be no movement of air nor bursting of bubbles in breathing. The mucous rattle is only possible with considerable liquid exudation into the bronchial tubes, and a healthy, dilatable condition of the portion of the lung to which these lead. In rare cases there will be splashing sounds in the chest, or when the patient has just risen to his feet a succession of clear ringing sounds, becoming less numerous and with longer intervals until they die away altogether. These are due to the falling of drops of liquid from shreds of false membrane in the upper part of the chest through an accumulation of gas into a collection of liquid below. It has been likened to the noise of drops falling from the bung-hole into a cask half filled with liquid. Peculiar sounds are sometimes heard, as wheezing, in connection with the supervention of emphysema, and others which it is needless to mention here.

In lean patients pressure of the tips of the fingers in the intervals between the ribs will detect less movement over the diseased and consolidated lung than on the opposite side of the chest where the lung is still sound.

As seen in America, in winter, the great majority of cases fail to show the violence described in books. The patients fall off rapidly in condition, show a high fever for a few days, lie always on the same side (the diseased one) or on the breast, and have a great portion of one lung consolidated by exudation and encysted as a dead mass, and yet the muzzle is rarely devoid of moisture, the milk is never entirely suspended, and may be yielded in only a slightly lessened amount as soon as the first few days of active fever have passed.

During the extreme heats of summer, on the other hand, the plague manifests all its European violence. The breathing becomes short, rapid, and labored, and each expiration is accompanied by a deep moan or grunt, audible at some distance from the

animal. The nostrils and even the corners of the mouth are strongly retracted. The patient stands most of its time, and in some cases without intermission, its fore legs set apart, its elbows turned out, and the shoulder-blades and arm-bones rapidly losing their covering of flesh, standing out from the sides of the chest so that their outlines can be plainly seen. The head is extended on the neck, the eyes prominent and glassy, the muzzle dry, a clear or frothy liquid distils from the nose and mouth, the back is slightly raised, and this, together with the spaces between the ribs and the region of the breast-bone, are very sensitive to pinching: the secretion of milk is entirely arrested, the skin becomes harsh, tightly adherent to the parts beneath, and covered with scurf, and the arrest of digestion is shown by the entire want of appetite and rumination, the severe or fatal tympanies (bloating), and later by a profuse watery diarrhea in which the food is passed in an undigested condition. If the infusion into the lungs or chest is very extensive, the pallor of the mouth, eyelids, vulva, and skin betrays the weak, bloodless condition. The tongue is furred, and the breath of a heavy, feverish, mawkish odor, but rarely fetid. Abortion is a common result in pregnant cows.

During the summer the disease shows its greatest violence, and it is then that its mortality is not only high but early. The great prostration attendant on the enormous effusion into the organs of the chest, the impairment of breathing, and the impairment or suspension of the vital functions in general, causes death in a very few days. In other cases the animals die early from distention of the paunch with gas, while in still others the profuse scouring helps to speedily wear out the vital powers. In certain severe cases the rapid loss of flesh is surprising. Dr. Law says that in such cases a loss of one-third of the weight in a single week is by no means uncommon, and even one-half may be parted with in the same length of time in extreme cases. In fatal cases all symptoms become more intense for several weeks, the pulse gradually becomes small, weak, and accelerated, and finally imperceptible; the breathing becomes rapid and difficult, the mucous membranes of the mouth, eyes, &c., become pale and bloodless, emaciation goes on with active strides, and death ensues in from two to six weeks. Sometimes, in cold and dry weather, a portion of dead lung may remain encysted in the chest, submitting to slow liquefaction and removal, and such animals will go on for months doing badly, at last to sink into such a state of debility that death ensues from exhaustion and weakness. In still other cases the retention of such diseased masses, and the consequent debility, determines the appearance of tuberculosis, from which the animal dies. Purulent infection and rupture of abscesses into the chest are also causes of death, but the author states that no such cases have come under his observation.

Dr. Law gives the following description of the *post-mortem* appearances:

If the disease is seen in its earliest stages, the changes are altogether confined to the tissue of the lung. From the examination of the lungs of several hundred diseased animals, I can confidently affirm that the implication of the serous covering of the lung (pleura) is a secondary result. In all the most recent cases we find the lung substance involved and the pleura sound, while in no one instance has the pleura been found diseased to the exclusion of the lung tissue, or without an amount and character of lung disease which implied priority of occurrence for that. Yet, in all violent attacks the disease will have proceeded far enough to secure implication of the pleura as well, and hence we may describe the changes in the order in which they are usually seen when the chest is opened. The cavity of the chest usually contains a quantity of liquid varying from one or two pints to several gallons, sometimes yellowish, clear, and transparent, at others slightly greenish, brownish-white, and opaque, or even exceptionally slightly colored with blood. This effusion contains cell-forms and granules, and gelatinizes more or less perfectly when exposed to the air.

On the surface of the diseased lung, and, to a less extent, on the inner side of the ribs, is a fibrinous deposit (false membrane), varying from the merest rough pellicle to a mass of half an inch in thickness, and, in the worst cases, firmly binding the entire lung to the inside of the chest and to the diaphragm. These false membranes are usually of an opaque white, though sometimes tinged with yellow, and, in the deeper

layers, even blood-stained, especially over an infarcted lung. A noticeable feature of these false membranes, and one that serves to distinguish them from those of ordinary pleurisy, is that they are commonly limited to the surface of the diseased portion of lung, or, if more extensive, that portion which covers sound lung-tissue is much more recent, and has probably been determined by infection from the liquid thrown out into the chest.

In the lung itself the most varied conditions are seen in different cases and at different stages of the disease. The diseased lung is solid, firm, and resistant, seems to be greatly enlarged, because it fails to collapse like the healthy portion when the chest is opened; is greatly increased in weight, and sinks in water. When cut across it shows a peculiar linear marking (marbling) due to excessive exudation into the loose and abundant connective tissue which separates the different lobules of the ox's lung from each other. This exudation is either clear, and therefore dark, as seen by reflected light, or it is of a yellowish-white, and when filled with it the interlobular tissue appears as a network, the meshes of which vary from a line to an inch across, and hold in its interspaces the pinkish-gray, brownish-red, or black lung tissue.

When only recently attacked the lung may present two essentially different appearances.

1. Most frequently the changes are most marked in the interlobular connective tissue, which is the seat of an abundant infiltration of clear liquid, a sort of dropsy, while the lung-tissue, surrounded by this, retains its normal pinkish-gray color, and is often even paler, and contains less blood than in health. It has, in short, become compressed by the surrounding exudation, and air and blood have been alike in great part expressed from its substance. (See Plate I.) This extreme change in the tissue surrounding the lobules and the comparatively healthy appearance of the lobules themselves, have led many observers to the conclusion that the disease commenced in the connective tissue beneath the pleura and extended to the proper tissue of the lung. There is, however, as pointed out by Professor Yeo, a coexistent disease of the smaller air-tubes corresponding to the lobules that are circumscribed by this infiltration, and there is every reason to believe that the infiltration in question is the result of antecedent changes in the air-tubes.

2. Less frequently we find the lobules of the lung-tissue presenting the first indications of change. The lobules affected are of a deep red, and more or less shining, yet tough and elastic. They do not crepitate on pressure, yet they are not depressed beneath the level of the adjacent healthy lung-tissue as they would be if collapsed. The interlobular connective tissue, devoid of all unhealthy exudation, has no more than its natural thickness, and reflects a bluish tint by reason of the subjacent dark substance of the lung. Here the lung-tissue itself is manifestly the seat of the earliest change—congestion—and the interlobular exudation has not yet supervened. Specimens of this kind may be rare, but a number have come under the writer's observation, and in lungs, too, that presented at other points of their substance the excessive interlobular exudation.

Both of these forms show a tendency to confine themselves to particular lobules and groups of lobules of the lung. They correspond, in short, to the distribution of particular air-tubes and blood vessels, as will be explained further on. The fact, however, is noteworthy as characteristic of the disease, that it attacks entire lobules, and the limits of the diseased lung-tissue are usually sharply marked by the line of connective tissue between two lobules, so that one lobule will be found consolidated throughout, and the next in a perfectly natural condition.

The two forms just described differ also in cohesion and power of resistance. The lung saturated with the liquid exudation has its intimate elements torn apart, and is more friable, giving way readily under pressure, while that in which there is red congestion but no extensive exudation retains its natural elasticity, toughness, and power of resistance.

Another condition of the diseased lung-tissue, more advanced than either of those just described, is the granular consolidation or hepatization. In this condition the affected regions of lung are as much enlarged as in the dropsical condition, but they are firmer and more friable, and on their cut surface present the appearance of little round granules. These granules are not peculiar to the lung-tissue proper, though most marked on this; they characterize the interlobular connective tissue as well. They consist mainly of lymphatic cell growths, filling up the air-cells, the smaller air-tubes, the lymph spaces, and the meshes of the connective tissue. The color of these portions varies from a bright reddish-brown to a deep red, according to the compression to which the lung-tissue has been subjected by the exudation in the early stages. (See Plate I.)

Another form of lung consolidation is of a very dark red or black, and always implies the death of the portion affected. The dark aspect of the diseased lobules forms a strong contrast with the yellowish-white interlobular tissue, excepting in cases where that also becomes blood-stained, when the whole presents a uniform dark mass.

This form has the granular appearance of that last described, and on microscopic examination its minute blood-vessels are found distended to their utmost capacity with accumulated blood globules. This black consolidation is always sharply limited by the borders of certain lobules or groups of lobules which are connected with a particular air-tube and its accompanying blood-vessels, and the artery leading to such lobules is as constantly blocked by a firm clot of blood. The mode of causation is this: the artery, being in the center of a diseased mass, becomes itself inflamed. As soon as the inflammation reaches its inner coat, the contained blood coagulates; the vein is usually blocked in the same way. The blood formerly supplied by the artery to certain lobules is now arrested; that in the capillary vessels of these lobules stagnates; nutrition of the walls of the capillaries ceases, and these, losing their natural powers of selection, allow the liquid parts to pass freely out of the vessels, leaving the globules only in their interior. More blood continues to enter them slowly from adjacent capillaries supplied from other sources, and as this is filtered in the same way by the walls of the vessels, these soon come to be filled to repletion by the globules only; and hence the intensely dark color assumed. The color is often heightened by the escape of blood from the now friable vessels into the surrounding tissue, and it is by this means that the interlobular tissue is usually stained. (See Plate I.)

This black hepatization, or, as it is technically called, *infarction*, is an almost constant occurrence in the disease as seen in New York, and the death and encysting of large portions of lung is therefore the rule. If too extensive, of course, the patient perishes, but not unfrequently a mass of lung measuring four or six inches by twelve is thus separated without killing the animal.

If at a later stage we open an animal which has passed through the above condition, the following may be met with: A hard resistant mass is felt at some portion of the lung, usually the lower and back portion, and on laying it open it is found to consist of dead lung-tissue in which the hepatized lobules and interlobular tissues, the air-tubes, and blood-vessels are still clear and distinct, but the whole is separated from the still living lung by a layer of white pus-like liquid, outside which is a dense, fibrous sac or envelope, formed by the development of the surrounding interlobular exudation. From the inner surface of this dense cyst, the firm, thick bronchial tubes and attending vascular systems project in a branching manner like dirty white stalactites, and these, with the interlobular tissue thickened by its now firmly organized exudation, may form bands extending from side to side of the cavity.

At a still more advanced stage the dead and encysted lung-tissue is found to have been entirely softened, and the sac contains but a mass of white liquid *debris*, or, still later, a caseous mass of its dried, solid matters, upon which the fibrous covering has steadily contracted, so as to inclose but a mere fraction of its original area. In hundreds of *post mortems* we have only once seen the dead and encysted lung the seat of putrid decomposition, and never found the cavity opening into a previous air-tube.

There remains to be noticed the condition of the air-tubes and accompanying vessels in the diseased lungs. In all cases where we see the starting point of the disease we find in the small tubes leading to the affected lobules a loss of the natural brilliancy of the mucous membrane, which has become clouded and opaque, and the tissue beneath it infiltrated and thickened. In more advanced cases, and above all in those showing the dropsical condition of the interlobular tissue, we find a similar infiltration into the connective tissue around the air-tubes and their accompanying vessels, and in the hepatized lung this is always seen as a thick, firm, resistant, white material, having the compressed and contracted and often plugged air-tubes and vessels in the center. (See Plate I.) These thickened masses have already been referred to as standing out in stalactite form from the inner wall of the sac in which the dead (necrosed) lung is undergoing solution.

As to the nature of the plague, Dr. Law states that there can be no doubt but it is determined by an infecting material conveyed in some manner from one beast to another. The intimate nature of this material has never been determined. No special anatomical element, no specific organism of animal or vegetable origin, has been detected as constant in the diseased organ and peculiar to it, yet the presence of a specific *contagium* has been fully demonstrated in all the experience of the disease by the author and others. This infecting material, as shown by the records of inoculation, rarely affects the lungs when first lodged on a raw surface of some other part of the body, differing in this essentially from most other specific disease poisons, which have a definite seat of election in which their morbid processes are invariably established, no matter by what channel they may have been communicated. Since this

contagium does not usually affect the lungs when introduced by some other channel, it follows of necessity that when it does attack the lungs it must have been introduced directly into them. If inhaled in the air breathed, it will fall upon one of two points—the air-tubes or the air-cells—and there begin its baleful and destructive course. This is exactly in accordance with the early lesions of the disease as found by Dr. Law in his *post-mortem* examinations.

In treating of preventive measures, Dr. Law quotes an article prepared by him and published in the National Live-Stock Journal for March, 1878. This valuable paper was afterwards transferred to the pages of special report No. 12 of this department, issued in September last. Following this is a brief summary of the work of the New York commission in its efforts to stamp out the disease in that State; but as the department has later advices from the author in regard to the work actually accomplished by this commission, extracts from Dr. Law's letter are given in preference to quotations from this monograph work. The letter bears date of New York City, December 9, 1879, and contains, among other things, the following:

To place our work in a "nutshell," I would say that in the past ten months the inspectors in New York have examined 40,000 head of cattle, many of them several times; that we have slaughtered and indemnified the owners for 590 head of diseased cattle, and that we have all but exterminated the plague from seven of the counties in which we found it. At present the main center of the plague is in Kings County and the adjacent border of Queens County.

In all country districts, where the cattle are kept on inclosed farms, and where the people heartily co-operated, the work has been easy and in every case speedily crowned with success. In the cities and suburbs, on the other hand, where cattle had been accustomed to graze on open lots, where interchange between different herds was frequent, and where the facilities for secret slaughter favored the covering up of the disease, the greatest difficulties had to be overcome. In New York City we secured the hearty co-operation of the police, and effectually arrested all movement between city stables, allowed only sound animals from healthy counties to enter these stables, and none to leave save to immediate slaughter, and, finally, promptly slaughtered all acute and chronic cases of the disease and saw to the disinfection of the premises, and the most gratifying success crowned our efforts.

In Brooklyn, on the other hand, where our work was systematically opposed, where the aldermen defied the State law by passing an ordinance authorizing the pasturage of cattle on open commons and unfenced lots, and some of them signed special permits for the movement of cattle in defiance of General Patrick's authority, and where magistrates dismissed offenders who were brought before them and reprimanded the policemen who had made the arrests, we soon lost the assistance of the police, which was at first all we could wish, and we naturally failed to meet with the splendid success seen in New York.

It became evident early in the work that unless we could establish special inspection yards under our own control, and abolish the system of distributing cows and other store cattle from dealers' stables, our success would be very partial and slow. In New York we were enabled to do this through the liberality of the Union Stock Yard Company, who built new yards for this purpose, which we opened July 1. In Brooklyn no such favor awaited us, and as the appropriation made by the legislature would not meet the needful outlay and enable us to hold what we had gained until the legislature should again meet, we had to be content with a system which was confessedly ineffective. By the end of August the approaching exhaustion of the appropriation compelled the dismissal of one-half of our veterinary force, and soon after we had to stop nearly all indemnities and consequently nearly all killing. Fortunately, New York City was now so nearly sound that we could continue the work there with but one inspector in addition to the one in attendance at the Union Stock Yard, and we could still kill and indemnify for all sick cattle in the city. Brooklyn, still widely infected, and with authorities still somewhat inimical, could only have her infected herds quarantined, and in her the scourge is but very partially abated.

In certain outlying districts most gratifying results have been secured. In May we learned that animals from an infected herd had been turned on the Montauk pasture on the east end of Long Island. The range was visited and eighteen animals killed to save the 1,100 that remained. Later, two other cases developed in animals that had been in infected herds and had been overlooked at the first visit. Fortunately,

for some months at first the cattle turned on this immense range kept apart from each other in small groups, composed of such only as had herded together prior to their coming on the range, and this most fortunate condition, coupled with the prompt disposal of each animal as it sickened, secured the escape of 1,100 animals. Had the occurrence been later in the season, when the cattle had learned to come together into one great herd, the results must have been most disastrous.

A second case is that of Putnam County, in which the plague had been smouldering since 1878, but was only discovered in September last. The State appropriation would not warrant us to offer indemnities, but the county authorities promptly assumed the responsibility, and every herd in which infection was found to exist was at once exterminated. In this way six herds have been disposed of, consisting of about 100 head, and a seventh, where sickness has existed for months but where it has only just been discovered, will be attended to to-morrow.

As regards the future, I would strongly urge the National Government to assume not only the direction but the execution of this work of stamping out the plague. The following among other reasons require this:

1. The disease is an exotic, and if once suppressed could only reappear in America as the result of importation.

2. It is gradually extending, and if neglected must lay the entire continent under contribution.

3. If it reached our unfenced ranges in the West it would be ineradicable, as it has proved in the European Steppes, in Australia, and in South Africa.

4. As the seeds remain latent in the system for three months, infected cattle may be moved all over the continent, from ocean to ocean and from lakes to gulf, and live for a length of time in a new herd before they are suspected.

5. Old cases with encysted masses of infecting matter in the lungs may show no obvious signs of illness, and may be bought and sold as sound and mingle with many herds in succession, conveying infection wherever they go. There is, therefore, the strongest temptation for the owner to seek to secure a salvage by the sale of apparently sound but really infecting animals. There is further the strongest probability that in a new locality these cattle would not be suspected until one or more herds had been irretrievably ruined.

6. The infection of the South and West would inevitably spread the infection over the whole Middle and Eastern States, as infection would pour in continuously through the enormous cattle traffic, and all rolling-stock, yards, &c., of railways would become infected.

7. The live stock bears a larger proportion to the State wealth West and South than in the East, hence the West has most at stake in this matter, and should bear its share in the work of extermination.

8. The plague is more violent in proportion to the heat of the climate, so that it will prove far more destructive in the semi-tropical summers of the South and West than on the Atlantic seaboard.

9. No State can be rendered secure unless all States are cleared of the pestilence. One remaining center of infection on the continent is likely to prove as injurious as the one infected cow landed in Brooklyn in 1843, the sad fountain of all our present trouble.

10. It has been decided by a United States Supreme Court in Illinois, that a State law forbidding the introduction of cattle from a neighboring State, because it is feared they may introduce disease, is unconstitutional. Therefore each State must keep a guard along its whole frontier, with quarantine buildings, attendants, and inspectors, and must quarantine all cattle as soon as they shall have crossed.

11. Smuggling is inevitable so long as there are distinct authorities in two adjacent States. Rascally dealers have repeatedly run cattle into New York from New Jersey, sold them and returned with their money before the matter could be discovered and the law officers of New York put on their track. Were the law and execution one for all the States such men could be apprehended and punished wherever found. In Europe it is found that an armed guard with intervals of 200 yards patrolling the whole frontier day and night is not always sufficient; how much less, therefore, with us a law that can be evaded with such impunity.

12. Finally, there is little hope of Delaware, Maryland, and Virginia stamping out the plague at their own expense, so that unless the United States takes the matter up, the work of New York, New Jersey, and Pennsylvania will be but money thrown away.

This is a matter which threatens with dire disaster the inter-State live-stock trade of the future, and the National Government is called upon to stamp out the scourge with the view of protecting the trade between States.

As respects the organization that should be charged with the work, it certainly ought to have a responsible head, and while the live stock interests should be represented, it should not be made too unwieldy to act at a moment's notice in any

emergency. The conditions of success are well enough understood, and while special adaptations would be demanded in many localities, yet the work should be carried out actively without the necessity of calling together a large and unwieldy committee before anything can be done.

Another point of vital importance is that a sufficient sum of money should be appropriated for this exclusive purpose, to obviate the necessity of stopping the work or giving it a material check before success shall have been accomplished. Any material arrest or any entire cessation of the work and a renewed spread of the disease will bring the whole question of veterinary sanitary work into disrepute, and may be the means of indefinitely and fatally postponing further action. While a large sum should be appropriated, its expenditure may be sufficiently guarded, but above all it should not be a common fund to be devoted to this and other objects. Aside from the moral question, this is of far more immediate importance than even yellow fever, the germs of which are destroyed by frost, and the neglect of which for one year places the sanitarian in no greater difficulty for the next. With a disease like the lung plague, which is favorably affected by no change of climate nor season, and the germs of which survive all extremes of heat and cold, the loss of a year, a month, or even a day, may make the difference between an easy success and disastrous and irremediable failure—a live-stock interest which can supply the world with sound beef, and a general infection of the continent, and continuous embargo on the foreign trade.

REPRESSIVE MEASURES ADOPTED IN PENNSYLVANIA.

The department is indebted to Mr. Thomas J. Edge, secretary of the Pennsylvania State Board of Agriculture, for advance sheets of his forthcoming report on the subject of contagious lung plague of cattle. After citing the history of the disease in Europe and in this country, and alluding to its long presence in Pennsylvania in a malignant and destructive form, Secretary Edge states that finally, but not until after the farmers of the State had sustained heavy losses, a meeting of the dairymen of Delaware, Montgomery, and adjoining counties was called. This meeting was held in Philadelphia in March last, and before its adjournment a committee was appointed to wait upon the secretary of the board of agriculture and urge the importance of legislative action. The veterinary surgeon of the board, in company with this committee, visited herds supposed to be infected. Surgeons who had had years of experience with the disease in Europe and elsewhere were also called in; *post-mortem* examinations were made, and the existence of the malady established beyond a doubt. The legislature being in session, the secretary of the board laid all the evidence before the joint committee of agriculture, and, after discussion and mature consideration, it was decided that the State should adopt a line of precautionary and preventive action, not only for the benefit of its own citizens, but also out of respect to the action of adjoining States. A subcommittee was, therefore, appointed to consult with the governor, and, if deemed expedient, they were instructed to draft an act providing for the suppression of the disease. After consultation, the following resolution was offered and adopted by both branches of the legislature:

WHEREAS, The States of New York and New Jersey, by recently enacted laws to prevent the dissemination among live stock of the disease known as pleuro-pneumonia, now invite this State, by a concert of action, to assist them to eradicate this contagion: Therefore,

Resolved by the Senate (if the House of Representatives concur), That the governor be, and he is hereby, authorized to take such preliminary action as may be necessary to prevent its further spread.

This resolution was approved by the governor March 27, 1879. At the same time, an act previously adopted by the committee was introduced, which, after amendment, passed both branches of the legislature,

and was approved by Governor Hoyt May 1, 1879. The enactment bears the title of "An act to prevent the spread of contagious or infectious pleuro-pneumonia among the cattle in this State," and is as follows:

SECTION 1. *Be it enacted, &c.*, That whenever it shall be brought to the notice of the governor of this State that the disease known as contagious or infectious pleuro-pneumonia exists among the cattle in any of the counties in this State, it shall be his duty to take measures to promptly suppress the disease and prevent it from spreading.

SECTION 2. That for such purpose the governor shall have power, and he is hereby authorized, to issue his proclamation, stating that the said infectious or contagious disease exists in any county or counties of the State, and warning all persons to seclude all animals in their possession that are affected with such disease, or have been exposed to the infection or contagion thereof, and ordering all persons to take such precautions against the spreading of such disease as the nature thereof may, in his judgment, render necessary or expedient; to order that any premises, farm, or farms where such disease exists or has existed be put in quarantine, so that no domestic animal be removed from said places so quarantined, and to prescribe such regulations as he may judge necessary or expedient to prevent infection or contagion being communicated in any way from the places so quarantined; to call upon all sheriffs and deputy sheriffs to carry out and enforce the provisions of such proclamations, orders, and regulations, and it shall be the duty of all the sheriffs and deputy sheriffs to obey and observe all orders and instructions which they may receive from the governor in the premises; to employ such and so many medical and veterinary practitioners and such other persons as he may, from time to time, deem necessary to assist him in performing his duty as set forth in the first section of this act, and to fix their compensation; to order all or any animals coming into the State to be detained at any place or places for the purpose of inspection and examination; to prescribe regulations for the destruction of animals affected with the said infectious or contagious disease, and for the proper disposition of their hides and carcasses, and of all objects which might convey infection or contagion (provided that no animals shall be destroyed unless first examined by a medical or veterinary practitioner in the employ of the governor aforesaid); to prescribe regulations for the disinfection of all premises, buildings, and railway-cars, and of objects from or by which infection or contagion may take place or be conveyed; to alter and modify, from time to time, as he may deem expedient, the terms of all such proclamations, orders, and regulations, and to cancel or withdraw the same at any time.

SECTION 3. That all the necessary expenses incurred under the direction, or by authority, of the governor in carrying out the provisions of this act shall be paid by the treasurer, upon the warrant of the auditor-general, on being certified as correct by the governor: *Provided*, That animals coming from a neighboring State that have passed a veterinary examination in said State, and have been quarantined and discharged, shall not be subject to the provisions of this act.

During the passage of this act the existence of the disease in the State had been denied. Hence, immediately after its approval, his excellency Governor Hoyt appointed a commission to "examine and determine whether infectious or contagious pleuro-pneumonia exists among cattle in any county or counties of this commonwealth, and report the same to the governor without unnecessary delay." This commission consisted of Hon. Samuel Butler and Hon. H. C. Greenawalt, on the part of the legislature; Thomas J. Edge and C. B. Michener, on the part of the board of agriculture; Hon. John C. Morris and George Blight, on the part of the Pennsylvania Agricultural Society; and George S. Garret, on the part of the dairymen of Philadelphia and vicinity. At the first meeting of this commission Hon. John C. Morris was elected president, and Thomas J. Edge secretary.

At a meeting held in Philadelphia May 16, 1879, a large number of practical dairymen and veterinary surgeons were examined, and their evidence taken down by a stenographic reporter. As a result of this meeting, Messrs. Morris, Butler, and Greenwalt were appointed a committee to report to Governor Hoyt, on behalf of the commission, that the disease did exist in at least two counties of the State, and that the decision of the commission was unanimous.

Under authority of the act before quoted, and based upon the report of the commission, his excellency Governor Hoyt appointed a special agent to take charge of the matter, to whom he issued the following commission:

It having been ascertained that an infectious and contagious disease of neat cattle, known as pleuro-pneumonia, has been brought into and exists in certain counties of this State, I hereby appoint you as my assistant to carry out the provisions of the acts of 1866 and 1879, for the prevention of the spread of this disease. As such assistant you are hereby authorized—

To prohibit the movement of cattle within the infected districts, except on license from yourself, after skilled veterinary examination under your direction.

To order all owners of cattle, their agents, employés, or servants, and all veterinary surgeons, to report forthwith to you all cases of diseases by them suspected to be contagious; and when such notification is received you are directed to have the case examined, and to cause such animals as are found to be infected with said disease to be quarantined, as also all cattle which have been exposed to the infection or contagion of said disease, or are located in any infected district; but you may, in your discretion, permit such animals to be slaughtered on the premises and the carcasses to be disposed of as meat if, upon examination, they shall be found fit for such use.

You may prohibit and prevent all persons not employed in the care of cattle therein kept from entering any infected premises. You may likewise prevent all persons so employed in the care of animals from going into stables, yards, or premises where cattle are kept, other than those in which they are employed. You may cause all clothing of persons engaged in the care, slaughtering, or rendering of diseased or exposed animals, or in any employment which brings them in contact with such diseased animals, to be disinfected before they leave the premises where such animals are kept. You may prevent the manure, forage, and litter upon infected premises from being removed therefrom; and you may cause such disposition to be made thereof as will, in your judgment, best prevent the spread of the disease. You may cause the buildings, yards, and premises in which the disease exists, or has existed, to be thoroughly disinfected.

You are further directed, whenever the slaughter of diseased animals is found necessary, to certify the value of the animal or animals so slaughtered, at the time of slaughter, taking into account their condition and circumstances, and to deliver to their owner or owners, when requested, a duplicate of such certificate. Whenever any owner of such cattle, or his agent or servant, has willfully or knowingly withheld, or allowed to be withheld, notice of the existence of said disease upon his premises, or among his cattle, you will not make such certificate.

You are also directed to take such measures as you may deem necessary to disinfect all cars or vehicles or movable articles by which contagion is likely to be transmitted. You will also take such measures as shall insure the registry of cattle introduced into any premises on which said disease has existed, and to keep such cattle under supervision for a period of three months after the removal of the diseased animal and the subsequent disinfection of said premises.

You are further authorized and empowered to incur such expenses in carrying out the provisions of the foregoing orders as may, in your judgment appear necessary, and see to it that all bills for such expenses be transmitted to this department only through yourself, after you have approved the same in writing.

The agent appointed by the governor at once issued the following notice:

To all owners of cattle, their agents, servants, or employés; to all common carriers by land or water; to all veterinary surgeons; and to all others whom it may concern:

His excellency Governor Hoyt having decided to co-operate with the executive officers of the States of Massachusetts, Connecticut, New York, and New Jersey in a united effort to eradicate the disease known as pleuro-pneumonia from the herds of this State, it becomes my duty, under the foregoing commission, to request that you will promptly report to me all cases among neat cattle by you suspected to be contagious or infectious. Without your co-operation and assistance this attempt can only result in partial success; with it the result can scarcely be doubtful, and the work thus far accomplished gives us assurance of good results.

His excellency is anxious that all owners of cattle and others interested should be fully impressed with the belief that this commission, as well as the laws of 1866 and 1879, for the prevention of the spread of the disease, are in their interest as well as that of the State. It is also the wish of his excellency that while the provisions of these laws are fully enforced and made most effective, and their purposes promptly and fully accomplished, it shall at the same time be so managed as to cause the least

possible inconvenience and injury to all concerned, and with a minimum of expenditure to the State.

I would particularly call your attention to the language used by his excellency in relation to the line of action to be pursued when interested parties have concealed the existence of the disease in their herds. This provision is very important not only to the stock owner, but also to the State, for while the concealment of the existence of the disease will result in pecuniary loss to the owner of the stock, it, at the same time, greatly increases the danger of infection and the subsequent expense to the State. With your active co-operation in this respect we may hope for the prompt suppression of a disease which, while it has already caused a great loss to our stock owners, will, should it become established in our Western States, inflict an incalculable and lasting injury to the stock-raising interests of the whole nation. So far as known, all infected herds in this State have been quarantined and all diseased animals promptly isolated or killed. In the future, as in the past, it will be our duty to cause as little injury and inconvenience to the owners of stock as is consistent with our duties to the State, and to carry out, to the full letter, the directions of his excellency relative to the valuation of all stock condemned and killed.

All reports of supposed infection should be made direct to the office, and all interested are requested to accompany the report with a correct and full account of the location of the herd and the symptoms, in order that all unnecessary expense to the State may be avoided. No special line of action has yet been marked out for application to cattle in motion from one portion of the State to another, or to those in transit to other States, but it will be the duty of those in charge to cause the least possible inconvenience consistent with the best interests of the State.

Up to November 1, 1879, the agent of the governor quarantined twenty-seven herds, including four hundred and eight animals liable to infection, and distributed in the following counties: Adams, one; Lancaster, four; York, one; Bucks, one; Delaware, four; Montgomery, five; and Chester, eleven. Of these herds, eight (one in York, three in Montgomery, and four in Chester) were afterwards released from the quarantine and pronounced safe from another outbreak, except from a fresh infection from outside sources.

As soon as the supposed existence of the disease is reported, each animal in the herd is inspected by a veterinary surgeon in the employ of the State, and if the disease is found to exist is promptly quarantined to prevent its spread to adjoining herds; in order, and if possible, to prevent further contagion in the same herd, all diseased animals are appraised and killed.

The individual history of these herds is given as follows by the secretary:

No. 1.—In *York County*, infected by steers bought in Baltimore market. Six head were either lost by death previous to quarantine, or were killed for the purpose of stopping the disease. The whole herd were more or less affected, though a number had a very light attack, and when released from quarantine, September 4, were as well as they probably ever will be. A rigid quarantine, which was very much assisted by the local surroundings, and the prompt support of neighboring stock-owners, prevented the disease from infecting other stock; and the killing of diseased animals and the use of disinfectants prevented further loss.

No. 2, containing twenty cows, two bulls, and ten calves, was quarantined June 12. Previous to quarantine four head had died, and after the enforcement of the quarantine fourteen head were killed. With one possible exception, *all* the animals were affected, and a number of them are now in a condition in which they are worse than useless to the owner. In this case the evidence is strongly in favor of the theory that the owner conveyed the disease to his herd by assisting in the care of another infected dairy. No spread of the disease to adjoining farms; but it is quite probable that the disease was carried from this herd to herd No. 8 in the clothing or on the person of the owner, who administered medicine to both herds. This herd has furnished an illustration of the disease in one of its worst forms, but is now believed to be clear, but not beyond the danger of infecting other stock.

No. 3, in *Delaware County*, contained fifty head of stock, and previous to quarantine a number had died. The probability is that the disease was introduced by purchase. After passing into the charge of the State authorities, eleven of the herd were killed. This herd, with Nos. 2 and 7, furnish by far the most stubborn cases we have yet met with. In all three cases every animal had been repeatedly exposed to infection before

the existence of the disease was reported; and we may here state that when the first sick animals were promptly isolated, and the case reported, the loss by death has been very slight. By allowing the sick and well to run together, all are infected before the assistance of the State is asked.

Nos. 4, 5, and 5½ adjoin one another, and are all traversed by the same small stream. The disease seems to have originated on the upper farm, where the first sick animal died in the stream and was buried close to its banks. In No. 4, one animal died and one was killed; and in No. 5, the first one was promptly killed. In both cases, the importance of immediate isolation was understood and put in practice. Nos. 4 and 5 have been released from quarantine, but No. 5½ is still infected. Whether, in these cases the stream was the vehicle of contagion or not, we cannot say: but the almost simultaneous outbreak on the three farms can be accounted for on no other hypothesis.

No. 6 had lost eleven head previous to being reported and quarantined. With one doubtful exception, every animal had shown more or less of the effects of the disease, and its owner fully appreciated its contagious nature. Has been released from quarantine.

No. 7, in *Lancaster County*, was composed of forty-two animals, and when reported had been thoroughly infected by two sick animals running with the herd. In this herd, seven animals were killed in one day, and seven placed under quarantine; fifteen have been killed, and to all appearance the disease has been checked. The infection, no doubt, came from an adjoining herd, which in turn had been infected by stock from New York.

No. 8 is supposed to have been infected by the owner of No. 2 administering medicine to the animals after attending to his own. Seven head have been lost in this herd, and the others are not clear of the danger.

In No. 9, containing thirty-one head, the disease seems to have been checked by the prompt isolation and killing of one animal, and has since been released from quarantine.

Nos. 10, 11, and 12 are small herds, in two of which every animal exibited symptoms of the disease; but by rigorous care on the part of the owners, by isolating and the prompt death of infected animals, the loss has been small.

Nos. 13 to 20, inclusive, are herds which have been recently reported and quarantined, and, thus far, the losses in them have been slight. By the prompt action of the veterinary surgeon, assisted by care and co-operation on the part of the owner, it is hoped that most if not all of them have passed the worst point, and that some of them may be released from quarantine as soon as the proper time has elapsed.

No. 21 was infected by six cows purchased in the Philadelphia market, and showed itself ten days after the purchase. Of the six, five have died or been killed, and others are affected. The purchased cows have been traced to the Philadelphia drove yard, but here all further clue to the origin of the disease was lost.

No. 22, in *Montgomery County*, was quarantined October 24, and was infected by a cow purchased from a drover. At the time of purchase she was coughing, and when examined by our surgeon, a week afterwards, she was so far gone that the owner was willing to have her killed as worthless and without a value.

No. 23 was infected by contact with the animals in herd No. 16, previous to quarantine. At the request of the owner, who has insured complete isolation, they are being treated by our surgeon. In this case the fumes of burning sulphur seem to have been effective in preventing further trouble, but all the herd were or are more or less affected.

No. 24, containing thirty-three head, were, no doubt, infected by contact with herd No. 7, as, by accident, they were in the inclosure containing the former herd for a short time.

No. 25 was allowed by its owner to graze alongside of No. 7, with no separation other than that afforded by a creek and common fence. Before the infection was reported, most of the steers (fat) were sent to market, but one left on the farm has shown all the symptoms of the disease.

In addition to the care and supervision of cattle already in the State, the agent of the governor was given control of all stock brought in from Europe and not quarantined by the national authorities or those of other States. Under the regulations established all cattle must present a certificate of clearness from any contagious or infectious disease at the point of shipment in Europe. They must also be inspected on their arrival in the State by a veterinary surgeon in the employ and under the control of the governor's agent, must be quarantined closely at the expense of the importer, under the supervision of the State sur-

geon, and must be again examined at the close of the quarantine. If then found uncontaminated, a certificate is granted which will authorize their removal to any point in the State. In enforcing this quarantine, care is taken to consult the interests of the importers so far as it is consistent with the interests of the State. These precautionary measures are made necessary in order to protect the stock of the State, not only from infection by pleuro-pneumonia or lung plague, but also from rinderpest and the hoof and mouth disease, all of which are now prevalent in Europe.

The report of Secretary Edge concludes with a brief pathological history of the disease—its nature, symptoms, and lesions as shown in *post-mortem* examinations. It is accompanied by colored lithocaustic plates prepared by Prof. J. W. Gadsden, M. R. C. V. S., formerly of England, but now a resident of Philadelphia. These illustrations are given elsewhere, and are marked respectively Plates Nos. II and III.

Mr. Edge closes his report as follows:

In our dealings with the disease under the immediate direction of the government, we find many points upon which scientists differ, and which it would be impolitic for laymen like ourselves to endeavor to settle; but of one point we feel certain, and in which we have the indorsement of *every* practical man who has had the disease among his stock, and this is the contagious and dangerous nature of the disease. Whether the disease can only be conveyed from animal to animal by actual contact, or whether it can or cannot be conveyed in the clothing, by the excretion, breath, or animals of another tribe; whether the disease is of ancient or of comparatively recent origin; whether it can be carried from herd to herd by a stream of water; whether it can be intensified in its ravages by bad ventilation or bad treatment; whether a complete separation of a certain specified number of feet of space will or will not prevent infection; whether in its first stages it is or is not contagious; whether it will or will not affect sheep, are all questions for scientists to determine, and which are all lost sight of in the one great question in the solution of which we are engaged—can the disease be eradicated by prompt and rigid action in the manner proposed? If so, all these questions can be solved in the future; if not, then the future of our stock breeders is indeed precarious. In defense of the propriety of the action of the joint committee of the legislature, and of the legislature itself, as given in the foregoing pages, we have nothing to say, except that the end in view justifies the means. If by the expenditure of a thousand dollars by the State we can save hundreds of thousands to her stock breeders and stock owners, and as many millions to the country at large, then we think no one will complain. If the result in New York, New Jersey, and Pennsylvania shall demonstrate that this cannot be done, we may still point with pride to the fact that this action has saved more thousands than it has cost hundreds; has demonstrated to other States that when Pennsylvania is appealed to for co-operation in a good cause, she is not slow to respond; and that when so important an interest is in danger, the State is not slow in her attempt to extend a helping hand.

Professor Gadsden, of Philadelphia, Pa., writing under date of January 21, 1880, says:

The authorities in this State are still at work in stamping out the disease of pleuropneumonia among cattle. There are now but three infected herds left, and they are in three different counties of the State, viz., Delaware, Lancaster, and Lehigh, which are giving the authorities any trouble. Each herd will be kept in quarantine three months after the last trace of disease has disappeared. The owners of diseased cattle complain of the small sum paid per head by the State, but Secretary Edge is afraid to pay more for fear the good work will have to stop for want of means. I notice that the authorities in the State of New York have ordered all work suspended until the legislature shall have appropriated more money.

I inclose you a letter received this morning from J. C. Michener, a veterinary surgeon employed by Secretary Edge. It contains a "bundle of facts" proving the contagiousness of this disease, and shows the great folly of allowing this nefarious traffic in diseased animals. Many such cases as the one alluded to could be traced out in this State. Secretary Edge, in a conversation with me yesterday, said that he was satisfied the disease could be stamped out in this State if diseased animals were prohibited from entering it. He has spent only about one-half of the $3,000 appro-

prised for the purpose of eradicating the disease. At first he was obliged to pay extravagant prices for some of the diseased animals in order to satisfy the owners. Now he pays but $5 per head for animals suffering with the disease.

The following is an extract from Professor Michener's letter, alluded to by Professor Gadsden:

Your letter making inquiry in regard to the herd of Mr. C. Krauss, of Lehigh County, is at hand. This herd is affected by contagious pleuro-pneumonia beyond the possibility of a doubt, and it is equally as certain that the disease was brought here by a heifer that came from Baltimore through the Philadelphia cattle-yard. Mr. Jonas Graber, who sold the heifer to Mr. Krauss, has traced her back as far as Baltimore, and has kindly furnished me with the names of all the parties to the transaction. Krauss bought the heifer September 11. Within from two to three weeks his attention was attracted to her by her making a grunting noise. She was being fed for a family beef, and was stabled and pastured with the milch cows. She gradually pined away and died in about four weeks. She was examined, and one lung was found swollen solid and adhering to the ribs. A few days after she died other animals commenced to show symptoms, and the local cow doctors suspected pleuro-pneumonia. They had never had the disease in that locality. Pleading ignorance of the law and of parties intrusted with its execution, the disease was allowed to have its own way until December 13, when its existence was made known to the governor's special agent, Edge. Under his orders I visited the herd forthwith, found that two animals had already died, and that twelve more were sick. We killed ten of these and made *post-mortem* examinations of eight. We found them badly affected; all had the characteristic swollen, hard, marbled appearance of lung, and the adhesion that belongs only to contagious pleuro-pneumonia. The diseased lungs weighed from 25 to 45 pounds, and the healthy ones from 3½ to 4½ pounds. We have since killed one more, making thirteen in all which have been lost out of this herd. We have reason to hope that the disease is now under control, although ten more are slightly affected and twenty others have been somewhat exposed to the disease, yet still remain comparatively healthy. No pains have been spared to carefully isolate the sick from the well. Disinfectants have been liberally used and a rigid quarantine enforced. The disease has not spread from the Krauss farm, the location of buildings and surroundings all tending to prevent this.

In all of the seven herds that I have heretofore managed under direction of Mr. Edge, we have been eminently successful in stamping out the disease, and the owners are all well satisfied with the result of our management. Concert of action on the part of the States, with the hearty co-operation of the national government, will effectually rid the country (if not too long delayed) of this most insidious and dangerous enemy to our vast cattle interests. I have lost all patience with those who advocate other means than those now being employed by our commonwealth for the eradication of the disease. When men talk of the disease being curable, and not even a contagious malady, they only show their ignorance. The disease entirely destroys the functions of lung tissue, and can only be cured by the removal of diseased organs and the insertion or substitution of new ones—a feat the best surgeon would hardly undertake to perform.

REPRESSIVE MEASURES ADOPTED IN NEW JERSEY.

In compliance with the provisions of an act entitled "An act to prevent the spread of contagious or infectious pleuro-pneumonia among cattle," passed by the legislature of New Jersey during the session of 1878–'79, Governor McClellan appointed General W. H. Sterling as the head of a commission to form rules and regulations for the proper enforcement of the law. He commenced operations at Trenton, on March 15, 1879; and in order to determine the extent and location of the disease, he caused circular-letters to be addressed to the assessors of each township, to postmasters, farmers, and other prominent gentlemen throughout the State, requesting such information as they could give as to the existence and extent of the malady in their respective and more immediate localities. From the answers returned, he found that the disease was prevailing to a considerable extent in various sections of the State, and that there was, therefore, necessity for immediate and decisive action, if the plague was to be arrested.

SECTION OF DISEASED LUNG; recent case of Lung Plague. Thin end showed black hepatization; the centre, red hepatization; the thick end, interlobular infiltration. Several blocked vessels are shown.

Section of healthy lung (Cow), showing the abundance of interlobular cellular or connective tissue of a bright rose color. Average weight of either right or left lung, 3¼ pounds.

CONTAGIOUS LUNG PLAGUE OF CATTLE.

Report Commissioner of Agriculture for 1879. Plate III.

Section of the left lung of a Cow in an advanced stage of Contagious Pleuro-pneumonia, showing the characteristic marbled appearance formed by the exudation and consolidation of lymph into the interlobular cellular tissue.

Weight of left lung 37 pounds; right lung 5 pounds.

In April, General Sterling found it necessary to move his headquarters to Jersey City, in order to meet the requirements of moving cattle to and from the State of New York, from whence the New Jersey dairymen largely draw their supplies of fresh milch cows.

Dr. Holcombe was appointed as surgeon-in-chief, and Dr. Corlies designated as inspector of the abattoir at Jersey City. Four other veterinarians were appointed, and on the 1st of April were commenced regular inspections of the herds in Bergen and Hudson Counties. These counties were quarantined, in order that proper restrictions might be placed upon the movements of cattle in the absence of proper permits. All the ferries and boats on the eastern border engaged in carrying stock into New Jersey were prohibited from landing cattle, unless accompanied with a permit issued by General M. R. Patrick, of the New York State Commission, who had issued similar orders relative to the landing of stock in New York. Thus the carrying trade between the two States at this important point was effectually controlled.

From reports received from the western and southwestern portions of the State, General Sterling was convinced that the disease was being imported from Pennsylvania. Therefore, on the second day of August he appointed Mr. J. W. Allen an inspector, gave him written instructions, and dispatched him to Camden for the purpose of consummating arrangements with the different ferries plying between Philadelphia and the different ports of entry lying between Salem and Philipsburg, for the transportation of cattle from Pennsylvania, and the inspection of the same on their arrival in the State. His efforts were successful, and the ferry companies caused to be erected on the New Jersey side a sufficient number of sheds and pens to hold all cattle crossing from Pennsylvania until after a thorough inspection had been made. The officers of the Pennsylvania, New Jersey Central, and other railroads cordially co-operated with the State authorities, and soon all the principal avenues for the ingress of the disease were effectually closed. General Sterling closes his brief report as follows:

When we consider the number of cattle in this State, and estimate their value, the importance of this subject will be apparent. The number of cattle in the State on January 1, 1879, was 236,700, valued at $7,528,922. With a knowledge of the past history of the disease in this and other countries, and the difficulty of eradicating its as well as legislative enactments and precautionary measures hitherto adopted for it, prevention elsewhere, a grave responsibility will attach to those in power if the disease be allowed to obtain a foothold, destroying our best stock, checking one of the great interests of the State, and entailing losses appalling to contemplate.

The following is a brief summary of the results accomplished during the year:

The number of cattle found sick with the disease was 572. There were inspected 2,663 herds, containing 40,309 head of cattle.

Many cattle showing symptoms of disease were placed in quarantine and held until the incubative period had passed, being carefully watched during the mean time. When no other symptom than bronchial trouble was manifested the order of quarantine was removed.

The number of cattle found necessary to destroy in order to prevent the spread of the disease was 315, at an average cost to the State of $11.85 per head. There are now in quarantine 99 herds, containing 865 head of cattle, of which number 257 head have been condemned as suffering with contagious pleuro-pneumonia. The total expenses of the commission will aggregate about $19,000.

CONTAGIOUS PLEURO-PNEUMONIA—EXTENT OF ITS PREVALENCE.

REPORT OF DR. CHARLES P. LYMAN.

Hon. WILLIAM G. LEDUC,
Commissioner of Agriculture:

SIR: In compliance with the instructions contained in your letter of appointment, dated January 29, 1880, I left Washington on the 29th day of January last, for New York City, where I proposed to commence an investigation for the purpose, if possible, of determining the character and extent of the prevalence of the disease known as contagious pleuro-pneumonia or lung plague of cattle. On my arrival in New York I visited Dr. Liautard, from whom I learned that the disease still prevailed to some extent in Eastern New York and on Long Island, and that there was a reported outbreak at Haverhill, N. H. The New Hampshire State commissioner had pronounced this outbreak as of a sporadic character, yet the circumstances attending it were of a suspicious nature, at least sufficiently so as to throw doubt on the decision arrived at by the State commission, and I regarded a further investigation necessary in order to positively determine the matter. While in New York I gained some valuable information in regard to the disease in the adjoining State of New Jersey, which I propose to make use of on my return to that State.

I arrived in Boston on the 3d day of February, where I met Dr. Thayer, a member of the Massachusetts commission for the suppression of contagious diseases of cattle. He had made some investigations of the New Hampshire outbreak, and gave it as his opinion that the disease prevailing there was not contagious. However, he did not regard his *post-mortem* examinations as satisfactory, as he was in no case furnished with whole lungs. I also saw Dr. Billings here, who informed me that he had examined portions of diseased lungs of some of the affected cattle at Haverhill, N. H., and from the appearances he did not regard the disease as that of contagious pleuro-pneumonia. He did not regard his examination as satisfactory, however.

I left Boston on the 5th day of February for Concord, N. H., for the purpose of seeing Dr. A. H. Crosby, chairman of the State commission. He regarded the Haverhill outbreak as of a suspicious character, and advised me to visit that place at once and thoroughly examine the affected herd. He gave me an order for the slaughter of such animals as I might deem necessary for examination, and also a letter to the chairman of the board of selectmen for the town.

I arrived in Haverhill on the morning of the 6th, and in company with Mr. Parker at once proceeded to the farm of Mr. Merrill, the owner of the suspected herd. I found the animals suffering in various degrees from respiratory troubles. As the herd was supposed to have been infected by a drove of cattle from Canada, I asked Mr. M. when this drove stopped with him. He answered—

On the 11th day of September; the first case of sickness occurred about October 2 the animal died on the 2d of November, having been sick only about one week.

Which was the second animal attacked, and when?

The light-colored or Fisher cow. She was taken somewhere between the 7th and 14th days of November. The calves first showed symptoms of sickness about the 14th of November. They were taken sick one by one with an interval of about seven days between each, except in one instance, when two were attacked at the same time.

Mr. Merrill described the symptoms as follows:

Coughing is the first symptom. The nose is dry, and the animal stands with its back arched and elbows turned out. If forced to move briskly about it will cough and pant. The disease seems more severe during a thaw than when the weather is colder. There is some running from the eyes. The appetite is invariably good up to about twenty-four hours before death. From six to twenty-four hours before death occurs, the animal is not able to stand. As death approaches, the animal groans quite loudly, the breathing becomes accelerated, and the cough seems to come from a more or less solid body. In coughing, a calf will extend its nose on a level with its neck. This symptom has not been observed to so great an extent among the cows.

How many cows, calves, and yearlings did you have in the fall? How many of each have been sick, and how many have died?

In the fall I tied up the following named animals:

Cows	11 head.	Sick, 4 head.	Died, 1 head.
Calves	23 head.	Sick, 10 head.	Died, 6 head.
Yearlings	13 head.	Sick, 3 head.	Died, 0 head.
Total	47	17	7

How have these animals been housed, and how have they been fed?

The cows and yearlings were tied up on the same side of the barn in a long row, but the yearlings were kept at the further end of the building by themselves. The calves have all been kept together in a separate pen 15 × 12 × 7 feet. During the day they were all turned out into the barn-yard. The cows have been fed on roots and hay, the yearlings on hay alone, and the calves on hay and roots.

Mr. Merrill continued:

The cows from this strange herd were put into the barn-yard, and the calves into a little pasture adjoining. About a week after this herd left, my own calves broke into this pasture. That would make the date about the 18th of September. October 20th I brought home a drove of calves myself from the north, and the first calves taken sick were some of these driven calves.

This being the statement, I regarded a *post-mortem* examination necessary in order to settle the question as to whether this outbreak was occasioned by contagious pleuro-pneumonia. For this purpose I thought it best to take the "Fisher," or light-colored cow, as she was the first attacked and had been the sickest animal of the lot. She was, therefore, slaughtered. I found the lungs in a *perfectly healthy condition*. The pleura of the ribs still showed plain traces of previous inflammation, but she had so far regained her health as to commence to again lay on healthy fat. This cow *never* had contagious pleuro-pneumonia.

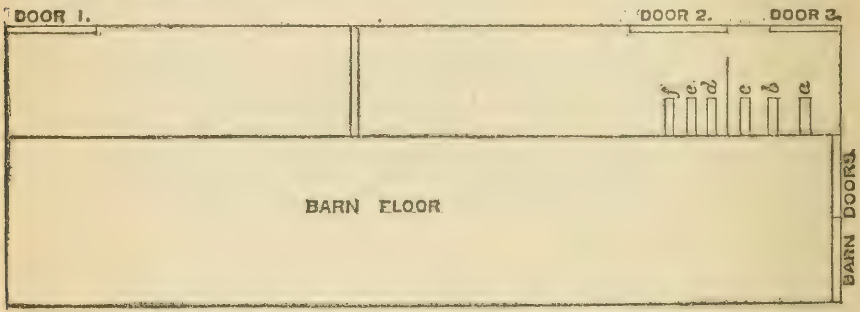
I found a calf quite sick, evidently in an almost dying condition. This was next killed, and an examination revealed the fact that it had been suffering from a clear and unmistakable attack of bronchitis. This I demonstrated to the satisfaction of the medical representative of the New Hampshire commission, Dr. Watson. There had been preserved a pair of lungs taken from a calf which had died a few days previously. These showed the lesions of sporadic pneumonia, with some bronchitis. All the specimens were sent to New York for the inspection of the profession.

CAUSE OF THE OUTBREAK.

In looking about for the cause of this outbreak, the buildings and the lay of the land in the immediate vicinity of the premises were thoroughly examined. The homestead is a meadow farm, lies well, and is inclosed by small hills, with a brook running a crooked course near to the buildings—a place that, in the fall of the year, would retain the fogs rising from the water for a considerable length of time. Further investigation proved this theory correct.

The calves, when removed from the meadow, where one or two of them had taken cold, were, about the 10th of November, put into a close shed 18 feet long, 12 feet wide, and 7 feet high. Here they were tied up in two rows, and were so close together that they completely packed the pen. This huddled condition, to my mind, furnished ample cause for the outbreak, for I do not think that a pen of such dimensions, with so many animals confined in it, could be sufficiently ventilated to preserve health in the absence of mechanical means. I advised the erection of another pen and a division of the herd.

I found that the cows had caught cold from being constantly subjected to a draft of cold air, so applied as to keep their bodies constantly bathed in a cold current. The arrangement of the barn is given in the following diagram:



The yearlings were turned in through door No. 1, and divided from the cows by a partition. This door was then closed, and they were left to themselves. The cows were turned in at door No. 2, which, together with the large barn-door, was open a considerable portion of the time. Door No. 3 was seldom used. Between the cows and the barn-floor was a board partition, with the board at the bottom *fixed to lift up*, thus leaving an open space fifteen inches wide directly in front of the cows and down at the floor. Except in *very* cold weather, this novel ventilating device was left open all the time. The air rushed in through the wide open door and the opening in front of the cows, passing over and bathing their bodies, and especially the under part of their breasts, chests, and abdomens, on its way out at door No. 2, which, by the way, is a little larger than any of the doors on this side. This cause I regarded as sufficient to give the toughest animal a cold.

In order to prove this theory correct, it is only necessary to state the following facts: Cow *a* in the diagram, a small and nearly black one, stood in the corner against the partition, *just* out of the line of draught, *and has never even coughed.* Cow *b* was the first animal taken sick, and the only one that died. Cow *c* was sick, but not so bad as either cows *b* or *e*. Being next the partition, even if on the cold side of it, may ac-

count for this in a measure. Cow *d* had been but very little troubled. She coughed slightly, but nothing more; the partition may have protected her. Cow *e*, the light-colored or Fisher cow, was the second one taken sick, and was more seriously affected than any of the others except the one that died. Of the four animals which were called sick, although the whole herd except cow *a* were more or less affected with coughs, cow *f* came third. The yearlings were turned in and tied up without any regard to regularity or place. Several of them coughed. Three of them were sick, *i. e.*, the respiration was considerably accelerated, but none of them died. It was advised to close up the feeding space next the floor and put it up in the partition 3½ or 4 feet from the floor, so that the draught through would be over the heads of the cattle.

It may be objected that this cause has been in operation for years, and no such trouble has before occurred. The only answer to this objection is that the past season has been remarkable for its sudden changes. I am told that it has not been uncommon here for the thermometer to vary from 30° to 40° in the course of twenty-four hours. These sudden changes are as liable to affect cattle as human beings, and where exposed as these were, without artificial covering, they could hardly be expected to remain exempt from serious colds. Another thing should be remembered: the past winter has been so mild that attendants no doubt became more careless than usual, and often neglected to close the doors and feeding-troughs.

CONNECTICUT.

In the course of my investigations in Connecticut the following facts were gleaned:

Statement of Hon. E. H. Hyde, chairman of commission.

An outbreak of contagious pleuro-pneumonia had occurred at Greenwich, occasioned by exposure to a calf which had been brought from New York and placed in the herd of Mr. B. Livingstone Mead. This farm is located on the State line, a part being in the State of New York and a part in that of Connecticut. The buildings are in Connecticut. This herd consisted of 20 head. From 7 to 9 animals have died, the last one about the 18th of March, 1879. The remainder are unaccounted for. These animals were at one time examined by Professor Law.

The herd of Daniel M. Griffin, on an adjoining farm, contracted the disease from Mr. Mead's herd. He had 27 head, 8 of which died. With the exception of one animal, Mr. G. sold the remainder of his herd to dealers in New York for slaughter. The one he retained remains with his tenant, and will soon be slaughtered on the place.

Joseph B. Husted, of Greenwich, took some cattle to New York for slaughter, among them two cows. They were all landed at the infected Sixtieth street yard. The cows were not sold, and after some hesitation on the part of the New York commission they were allowed to be returned to Connecticut, the commissioners of the last-named State being notified of the fact. The State authorities at once ordered them quarantined, but before the letter reached Mr. Husted he had sold them, and they are still untraced. They were taken away from Greenwich on or before July 11, 1879.

Mr. Curtis Judson, of Watertown, near Waterbury, keeper of the Gramercy Park Hotel, bought two cows from Hedge, a dealer in New York, and placed them in an excellent herd of his own at Watertown.

They proved to be affected with contagious pleuro-pneumonia, and soon infected the herd with which they had been placed. The herd was quarantined by order of the State commissioners, but the owner, on the 8th of March, 1879, broke quarantine and took them to New York. This fact coming to the knowledge of the authorities in time, they were enabled to be in New York on the arrival of the animals, where they were at once killed by order of the New York commission.

Mr. David D. Hawley, of Danbury, had an outbreak of disease in his herd on October 27, 1879. They were visited by Dr. Hopkins, of New York, who made an autopsy of a calf and pronounced the disease tuberculosis. The calf came from New York, and had been with the herd but a month.

Mr. Porter, of Waterbury, had an outbreak among his cattle on the 13th of November, which the attending veterinarian feared might prove to be contagious pleuro-pneumonia. The herd was visited by the State board on November 18, and the decision arrived at was that the animals were suffering simply from sporadic disease. No *post mortem* examination was made, and they are now reported as doing well.

Some trouble was reported among cattle at Hartland and Milford, but, on examination by the commissioners, the disease was decided to be sporadic.

I visited the herd of Mr. L. B. Mead, of North Greenwich, which I found suffering from contagious pleuro-pneumonia. Although the trouble was of long standing, some of the cows certainly were in a condition to convey the disease to healthy or non-infected animals. There were ten cows, one pair of oxen, one yearling, and six calves in this herd.

The herds of Daniel M. Griffin, Joseph B. Husted, David D. Hawley, and Mr. Porter were visited, but no cases of the plague were found. Reports from Watertown, Waterbury, North Brandford, Hartland, and Milford were of such an assuring character that I did not deem it necessary to visit those points.

NEW YORK.

I am indebted to the New York commission for the following statement made February 12, 1880:

Putnam County.—On the line of the Harlem Railroad there have been lately slaughtered 176 animals. Of these 40 were acute cases. The others, having been exposed to the contagion, were killed to prevent the spread of the disease. The beef was marketed.

In the town of Kent Joseph R. Sprague has an infected herd of 60 head of cows, steers, and calves. They are now in quarantine.

Westchester County.—In Yonkers Mr. Austin had a herd of 27 head, which had been reduced by the ravages of the disease to 8 animals. Mr. Peirpoint had a herd of 11 head, which had been exposed to infection. Two of these had been killed. Mr. Cheever, on Odell's farm, has a herd of 12 head that have been infected. Mr. Coyle has one animal infected.

In Croton Falls, Bedford Township, Mr. Butler, who generally keeps about 50 animals, has lost by death and slaughter his entire herd, with one exception.

New York City.—In the city there are believed to be but five infected stables left. These are in quarantine, and are located as follows:

No. 1. West Seventieth street. Old chronic cases.

No. 2. West Seventy-eighth street. Acute cases.

No. 3. East Ninetieth street and Madison avenue. Acute cases.

No. 4. East One hundred and twentieth street and Fourth avenue. Acute cases.

*No. 5. East One hundred and twenty-first street and Fourth avenue. Acute cases.

Long Island.—The whole western end of this island, as far back as Jamaica, is more or less infected. The stables of Gaff, Fleischmann & Co., of Blissville, originally the hot-bed of the disease, are now perfectly free from all contagion. Jamaica is located some 10½ miles back, therefore the infected district includes Brooklyn, New Utrecht, Flatbush, Gravesend, Flatlands, and New Lots, in Kings County, and Long Island City, Newtown, Jamaica, Flushing, and Creedmoor, in Queens County.

Suffolk County.—At the extreme eastern end of the island are extensive unfenced ranges, used as common pastures. The plague prevailed among herds grazing on these ranges, but it is now believed they are thoroughly freed from it, as the last known cases were destroyed at Montauk August 28, 1879, and at Bellport August 11, 1879. This portion of the island has been subjected to numerous examinations, and is now regarded as entirely free from the plague.

Staten Island.—A year ago one case of the plague was discovered on this island. The animal was killed. No case has since appeared, and the island is now regarded as absolutely free from the disease.

On the 12th and 13th days of February, in company with one of the New York inspectors, I visited several stables in Brooklyn. I found several chronic cases in these stables, but no acute ones. At Johnson avenue slaughter-house I was shown a portion of a characteristically-diseased lung, which had been taken from an animal killed a few hours previously.

On February 14 I visited the stables of Mr. Lang, One hundred and ninth street and Fourth avenue, New York, where I found three cows suffering with the plague. One of these was a very acute case, and I was informed had been afflicted but three days. This and one of the others had been condemned to the offal dock. Mr. Froudie, a neighbor of Mr. Lang, lost a cow on the 12th day of February by the disease. A week before he had bought a cow from a dealer named Louis, and the cow that died was taken sick on that day that this cow came to his stable. The nearest stable to Mr. Froudie's is on One hundred and twelfth street and Fourth avenue. Mr. Froudie had owned the cow he lost for eight months. Lang purchased his sickest cow from a dealer named Franke some four or five weeks previous. She was a "two-titter," and on that account Franke knocked off $5 on her price. She never did well. The other two commenced coughing three or four days before my visit.

On the afternoon of the same day I visited the offal dock and witnessed the autopsy of Lang's cows, alluded to above. Both cases revealed well-marked lesions of acute pleuro-pneumonia *contagiosa*. One of the animals, which showed a temperature of 105° Fahr., and 36 respirations per minute, had the whole posterior lobe of the left lung consolidated and strongly adherent to the costal pleura. The right lung was healthy. The pericardium was thickened to half an inch. In both lungs of the second cow were found a number of small isolated spots of the characteristic lesions of the disease, the largest being about the size of a double fist. Their borders were well defined, and the intermediate portions of the lung-tissue appeared perfectly healthy to the naked eye.

* The last-named stables were infected from One hundred and twentieth street.

On February 16, at One hundred and twentieth street and Fourth avenue, I found three cows which had been exposed to infection, and were in quarantine. They appeared healthy, and one had just been sold to a butcher named McEvoy.

In Tremont, at the stable of Mr. Bohle, I found two cows, one of which had been put into an infected stable on Christmas. Her temperature was 101° Fahr., and she was breathing at the rate of 30 respirations per minute. The other animal was a Jersey cow; both animals had been ordered slaughtered as soon as they could be got ready for the butcher. A Mr. Conners, a neighbor, had had some trouble with his herd, but they were quarantined and seemed to be doing well. The infection to this herd of Mr. Bohle's was communicated by a cow that was pastured with ten others on a common lot. She developed contagious pleuro-pneumonia, and was killed in the month of August. *Three months and nineteen days thereafter* the second animal was attacked and sent to the offal dock, where she was slaughtered. At the end of three weeks a third, and at the end of four weeks a fourth, animal was taken sick, and both were slaughtered. The first one of these animals belonged to Mr. B. Jorkman, the other three to Mr. Bohle, who, as has been before stated, bought a fresh cow on Christmas and put her in with one remaining from his original herd. This was in direct violation of the law and his instructions. She is now diseased and has been ordered to be killed. These ten animals were strictly isolated as soon as the first cow was killed, and no other infection was then possible. Two of them have since been fattened and sent to the butcher in a healthy condition. The remainder, with the exception of those belonging to Mr. Bohle, are still free from disease.

On the 17th day of February, in company with Professor Law and Dr. Hopkins, I visited the farm of Mr. Joseph Sprague, in Kent, Putnam County, whose herd was infected and had been in quarantine for some time. The herd consisted of 53 head, and were sold during the day by the State commission to butchers who had been notified to attend. The animals brought an average of $6 per head, which was regarded as a low price. Three of the animals were considered too badly diseased for beef, and on being killed showed well-marked lesions of the disease in its different stages. This herd was infected by a cow purchased from a dealer named Robinson.

On February 18, in company with the same gentleman, I visited Croton Falls, Westchester County. We found here a gentleman by the name of Butler, who had lost 31 animals out of a herd of 32 by the plague. His remaining cow was in quarantine, with no symptoms of the disease manifest. On the 15th of June last Mr. Butler bought 17 cows of Mr. Robinson, the dealer above referred to, and they were delivered to him on the 17th of the same month. They had been pastured all the summer on "Hyatt's lower farm" *with a cow that had been sick but had recovered.* The first animal on Butler's farm sickened on September 16, and soon died. The remaining 30 head were either slaughtered for beef or killed diseased.

On February 19, in company with the same gentleman, I visited the farm of Mr. Daniel Austin, in Yonkers, Westchester County. Originally this gentleman had a herd of 27 head, 18 of which had either died of the plague or had been killed for beef in the incipient stages of the disease. Five of the animals were killed for beef, and showed no lesions of the disease. Of the four remaining two are well-marked chronic cases, *i. e.*, having portions of encysted lung. This herd was infected

by a cow that had pastured on an unfenced range called "Hog Hill," in the town of Yonkers. She wandered into a field near Mr. Austin's place, where she died on the 27th or 28th of July, and was not buried for some days after. The disease appeared among Mr. Austin's cattle on October 21. The herd of Mr. Odell, on whose farm this cow died, was no doubt infected by the same animal. His herd consisted of some valuable Jerseys, among which the plague appeared on August 28. We killed three of his animals, and they all showed well-marked lesions of the disease.

On February 20, visited Mr. Tice, of Newtown, which is a suburb of Brooklyn, Long Island. His herd was infected about the middle of October. Eight of his animals died, and he had continued to fill their places with fresh ones. We found 12 of his animals suffering with the plague. Two cows were killed—one an acute and the other an older case—and both showed well-marked traces of the disease. His herd was infected by a cow sent him about the 20th of September.

A Mr. Grady, whose stables are in Blissville, a portion of the suburbs of Brooklyn, had lost 11 head of cows, out of a herd of 14, since the middle of September.

PENNSYLVANIA.

I arrived in Philadelphia on February 24, and during the evening visited and had a conversation with Dr. J. W. Gadsden, relative to the prevalence of the plague in Pennsylvania. Dr. Gadsden showed me a private telegram giving him the information that the British Government contemplates raising the embargo on *cattle transported from the Western and Southwestern States through Canada and shipped to Great Britain from ports of the Dominion Government.*

On the morning of February 25, in company with Dr. Francis Bridge, I visited the farm of Mr. J. F. Taylor, located near the town of Marple, Delaware County, Pa. We found the gentleman's herd suffering with the disease. Having selected and paid for four acute cases, the animals were slaughtered and examined. The *post mortem* examination revealed all the lesions of the disease in its acute stage. This herd was infected by a cow purchased by Mr. Taylor in the Philadelphia stock-yards. She was in very good condition, and when she arrived on the farm seemed very tired. Next morning she refused to eat and seemed sick. She died in a few days thereafter with all the symptoms exhibited by those that have since died of contagious pleuro-pneumonia.

On February 26 I visited the farm of Mr. Wynne, near Philadelphia. His herd originally consisted of 34 head. Ten of these had already been killed, and two had died of the disease. An examination of those left developed the fact that the disease was still present in both an acute and chronic form. The owner objected to the slaughter of any of the animals. His herd was infected by some cows he purchased in the Philadelphia stock-yards. The disease broke out about the first of June last.

On the 27th day of February I visited Messrs. Martin, Fuller & Co., who have charge of the Philadelphia stock-yards. They offered me every facility for an examination of the premises. During my interview with these gentlemen, Mr. Fuller said that something ought to be done to relieve the dealers in stock from the oppression of the English embargo—that the European trade is now carried on at a positive loss, and that this loss is clearly traceable to the embargo on our live cattle. He further stated that he was in Europe last season, and found the market flooded at Liverpool. His stock was detained fifteen days in quarantine

before it could be slaughtered. Besides the expense of feeding all this time, his animals were positively shrinking in weight—that when they were finally slaughtered he was compelled to accept any price offered He found dealers there who said they could afford to give from $15 to $20 per head more for the animals if they were allowed to drive them back into the country and slaughter them only as needed.

During the day I met, by appointment, Secretary Edge, special agent of the governor. He seemed to appreciate the fact that more thorough and active measures than those heretofore used are necessary for a complete suppression of the plague. He thinks the better plan would be to pay a good price for all exposed animals, and that in the country all exposed and infected animals should be slaughtered as well as those acutely diseased. Under existing circumstances he does not think it would be politic for the State of Pennsylvania to thoroughly eradicate the disease; indeed, he does not think this possible so long as the southern border of the State is unprotected from importations from Maryland. Until quarantine measures are established against this State, or the State itself takes some action for the suppression of the disease within its borders, the State of Pennsylvania cannot hope for success. The farmers of Pennsylvania will go to the Baltimore stock-yard to buy "frames," and in this way new cases are continually being brought into the State. Under the present construction of the law sufficient means to pay a fair indemnity cannot be obtained, and to kill even diseased animals without funds to pay for them, the secretary believes would result disastrously, as it would prejudice the farmers against a better law, which is hoped for in the near future. His policy is simply an effort to keep the disease within its present limits with the destruction of as few animals as possible. Up to January 1, 1880, the secretary had expended but $2,700 in repressive measures.

On February 28, while examining some cows at the stock-yards, I found an acute case of contagious pleuro-pneumonia. The affected animal was in a yard with some twenty other milch cows, and all were being offered for sale. This animal was seen also by Dr. Bridge.

On March 1, while examining lungs of slaughtered animals at the Philadelphia abattoir, I found one showing the well-marked lesions of the plague. The butcher said the animal came from Illinois, but it was afterwards traced to Cecil County, Maryland.

On the 2d day of March I visited Camden and learned some facts relative to the extent of the plague in New Jersey.

On the 3d instant I attended a meeting of the farmers and stock-raisers in the infected district. The meeting was held in Philadelphia, and was called for the purpose of devising means for the extirpation of the plague. During the day, visited Elm Station, Montgomery County, and assisted in selecting six diseased animals from Mr. Wynne's herd for the purpose of *post mortem* examination.

On the 4th and 5th days of March I was engaged in examining lungs of slaughtered animals at the Philadelphia abattoir. I found no traces of the disease, but on the 4th instant, while examining some cows at the stock-yards, I found a second case of the plague in an animal that came from near Gettysburg, Adams County, Pennsylvania.

The following are the sources of infection and locations of diseased herds in Pennsylvania:

Philadelphia County.—The Philadelphia stock-yards are infected. These yards are constantly receiving and sending out to different localities diseased and infected animals.

Chester County.—Mr. M. Corning, of Chester Valley, has a herd of 27 head, among which the disease has appeared. The herd was infected by a cow purchased from a drover, and the infection could not be traced.

Mr. J. Dickinson, of Chester Springs, has a herd of 23 head. These animals were infected by the owner, who brought the contagion from a neighboring farm where he had administered medicine to a diseased animal.

Mr. G. V. Rennard, Chester Valley, had a herd of 18 animals infected by his neighbor's cattle (Mr. Corning's).

Mr. Rennard's cattle had infected a herd of 14 head owned by Mr. J. W. Wilson,, his near neighbor.

Mr. C. Holland Frazer, of the same neighborhood, had a herd of 26 head infected by a purchased animal, which he was unable to trace.

Mr. W. Pugh, of Chester Springs, had his herd infected by Mr. Dickinson, alluded to above, who visited this herd for the purpose of administering medicine to a sick animal.

W. J. and H. A. Pollock, Downingtown, had a herd of 30 head infected by a purchased animal.

Mr. W. Reid, West Chester, herd of 5 head, chronic cases; source of infection unknown.

Mrs. Harmaan, West Chester, herd of 12 head; infected from neighboring cattle.

Mr. W. E. Penneypacker, Cambria, herd of 14 head; probably infected from neighboring herd.

Holmes and Bunting, Oxford, herd of 35 head; infected by Mr. Turner's cattle on adjoining farm.

Mr. M. Young, Bradford, herd of 36 head; infected by Mr. Turner's cattle.

Between the herds of Holmes and Bunting and Mr. Turner was a large meadow. The bulls broke down the two intervening fences, and the herds mingled in the meadow. The herds were separated as soon as men on horseback could separate them, but not soon enough to prevent infection.

Montgomery County.—Messrs. J. L. and A. S. Reiff, Worcester, herd of 15 head. Jacob L. Reiff had bought of five different dealers during May and June, and it was impossible to tell from which one the disease came. Two animals had died, and two others had been killed by order of the State inspector. Five others had been slightly affected, but had recovered. A. S. Reiff purchased a cow of his son in July, about the time of the outbreak. One animal died, and a second one was condemned and killed by order of the State inspector. Five other animals were affected, but all had recovered and had been released from quarantine.

Joseph Tyson, Worcester, herd of 13 head. Mr. Tyson purchased a cow of a man who had previously purchased her at the Philadelphia stock-yards. She was killed on September 24, 1879, by order of the State inspector, but as she had been isolated on the appearance of the first symptoms of the disease, only one other was infected.

Charles T. Johnson, Lederachsville. This gentleman's herd was infected by an animal purchased from a dealer. Up to the date of the first inspection in October last, five animals had died. One was afterwards condemned and killed. Five out of the remaining ten were affected, but had recovered.

Peter M. Frederick, Lansdale. Herd quarantined January 29, 1880. The infection was communicated by a cow purchased in the Philadelphia stock-yards. Two animals had been condemned and killed. The remainder—ten animals—were free from disease on March 4.

Jacob D. Wisler, Worcester. Herd quarantined February 6. Three animals had been condemned and killed, and three others were sick.

John C. Blattner, Worcester, herd of 16 head. The plague had prevailed in this herd in a mild form for the past four months. None of his animals died, and he did not suspect the nature of the disease. His cows were greatly reduced and he had been feeding at a loss.

One of his animals had commenced to lay on fat, and all were free from disease except the altered structure of the lungs, the natural result of the disease. This herd was infected by Mr. A. F. Reiff's cattle, mentioned above.

W. W. Latrobe, Merion, herd of 14 head.

W. Wynne, Elm Station, herd of 28 head. This gentleman had lost several animals. The infection came from a cow purchased at the West Philadelphia stock-yards.

Bucks County.—Aaron Yoder, Dublin. This herd was quarantined September 25. The first cow to sicken was one that he purchased two weeks previously. As she had passed through the hands of three different parties, it was impossible to trace her back satisfactorily. Three out of the four were affected, but had "recovered."

Isaiah Kletzing, Dublin. This herd received its infection from Yoder's cattle before they were quarantined. Three animals had recovered.

Lehigh County.—Charles Kraus, East Greenville. This herd was quarantined December 13. The infection came through a cow purchased at the Baltimore stock-yards. Two animals died and eleven were condemned to be killed. Thirty animals remain, and are thought to be free from disease.

Cumberland County.—Samuel Hess, Eberly's Mills. Herd quarantined March 20, 1879. Infected by cattle coming from Baltimore stock-yards. This herd is in York County.

Delaware County.—R. L. Jones, Upper Darby, herd of 43 head. Infected by purchase from Philadelphia stock-yards.

Thomas Cunningham, Upper Darby, herd of 21 head.

J. G. Haenn, Darby, herd of 14 head.

J. Likens, Ridleyville, herd of 15 head.

J. F. Taylor, Marple, herd of 36 head. One third of his animals had died, and the disease was still present.

Lancaster County.—J. F. Turner, near Oxford, Chester County, herd of 52 head. Infected by adjoining herd, into which the disease had been introduced by some calves brought from the State of New York.

David Williams, Coleraine. This herd had come in contact with the diseased Oxford herd, and was quarantined before any symptoms of the disease appeared.

Lane Gill, Coleraine, herd of 5 head, adjoining above.

Adams County.—J. Redding, Gettysburg, herd of 13 head. Infected by purchase from Baltimore stock-yards.

NEW JERSEY.

The following are the locations of some of the diseased herds in New Jersey at the time of my investigations in February:

Atlantic County.—Benjamin Gibberson, Port Republic, herd of 11 head. This herd was quarantined October 29, and again on November 28, as chronic cases. Eight animals had been affected by the disease.

R. A. Johnson and William Ramsay, both of Port Republic. The herds belonging to these gentlemen were diseased and in quarantine.

Gloucester County.—Charles B. Leonard, of Paulsboro, has two farms, upon one of which he has a herd of 22 animals, 6 of which are suffering with the plague. He has 28 animals on the homestead farm, only 1 of which has shown symptoms of the disease. Both herds are in quarantine.

Benjamin G. Lord, Woodbury, herd of 25 head. On June 13, 6 of these animals were suffering with the plague. October 27 there were 21 of these animals sick. On November 25 the same number were suffering with the disease, and were all in quarantine. Of the first lot of 25 animals, 6 were attacked and 3 died. He then bought four or five fresh animals. These remained in good health for five months and twelve days, but of the original animals 21 had suffered with the contagion.

Camden County.—An occasional case of pleuro-pneumonia had been found here, but no great amount of the disease had ever existed. A most thorough system of inspection of cattle coming from Philadelphia had been established here, and its rigid enforcement had undoubtedly been of great service in preventing the importation and spread of the contagion. From August 28 to December 15, 217 animals, known to have been exposed to infection, were returned to Philadelphia. Forty-one head of these were suffering with plain and unmistakable symptoms of the malady.

Burlington County.—Howard Stokes, West Hampton, herd of 11 head. Quarantined June 20, but did not obey quarantine regulations.

Job Ewan, Mount Holly, herd quarantined July 11. One acute case.

D. Maloney, Recklesstown. Lost 1 animal on January 26.

William Murray, Jacksonville, herd of 14 head. There have been 4 acute cases in this herd, and 2 animals have died. He will probably lose others. The herd was quarantined July 11.

Ocean County.—E. H. Jones, Forked River, herd of 20 head. There have been 27 acute cases in this herd. Six animals were killed on October 2, and on the 15th of the same month the balance were slaughtered. The infection to this herd was brought in some calves purchased in Fortieth street, New York City. From October, 1878, to October, 1879, Mr. Jones lost 32 animals by this disease.

At the same place as the above, Mrs. Strut has 1 animal, Captain Wilson 3, and James Holmes 23, all of which are infected and quarantined.

Mercer County.—C. E. Neunmaker, Pennington. On November 17 3 of his animals were suspected. On the 20th of the same month 2 acute cases had developed, and the herd was quarantined. One animal was slaughtered on January 17. Two animals recovered and are still on the place.

William Walton, Dutch Neck, herd of 32 head. On May 5, 1 acute case appeared. On May 15 the animal was very sick, and, as other cases were developing, the herd was quarantined. The owner did not believe his animals were affected with the plague, and failed to observe the quarantine regulations until one of the animals was killed in order to prove the fact. The herd becoming seriously affected, Mr. Walton sold, on October 29, all his animals to a butcher. This herd was infected by a cow purchased in New York. She calved, and her offspring, at five weeks old, showed well-marked lesions of contagious pleuro-pneumonia.

Monmouth County.—D. C. Robinson, West Freehold. One cow died of the plague on May 13. On the 19th of the same month another

cow showed symptoms of the disease, and the herd was quarantined. On June 11 3 more animals were sick, 1 of which has since died and a second one recovered. The quarantine is continued.

A. D. Vorhees, Adams's Station, herd of 5 head. One of the animals was found sick on October 13, and the herd was quarantined. On the 16th of the same month another animal showed symptoms of the disease. One of the afflicted animals was killed. On November 19 a third animal was taken sick. The herd is still in quarantine.

Pliny Parks, who resides on an adjoining farm, had a herd of 8 animals infected. One was killed and the remainder quarantined on October 16.

D. W. Watrous, Perth Amboy, herd of 13 head. His herd was quarantined March 29, 1879. October 13, nearly six months after, he still had 11 head. On February 5, 1880, having added to his herd, he had 13 animals, 3 of which were sick and the others reported as well (?). The 3 sick animals were quarantined and the remainder were set at large.

Isaac Morris, Metuchen, herd of 14 head. The first case of the plague was discovered in this herd on May 22. The animal was taken to the butcher and killed, and the herd quarantined, which is still continued.

Hunterdon County.—Joseph Exton, Clinton, herd of 51 head. On June 9, 18 of the animals were found suffering with the disease and were quarantined. The quarantine is still continued.

Morris County.—D. Frank Corl, Sterling, herd of 15 head. On March 26, 11 head were sick. On February 20, but 5 animals remained, 1 of these showing old lesions. They are in quarantine.

Benjamin Runyon, Millington, herd of 20 head, 12 of which were sick on June 13, when the animals were quarantined. Two animals were killed; and on the 26th of June 8 animals were sick out of the 18 remaining. Two new cases had occurred, but the others were improving. The herd is still quarantined.

Mary Smith, Chambers street, Newark, herd of 5 head. October 24 1 animal was sick. On the 28th of the same month a second 1 was attacked, and 2 were killed. On January 14 the others were reported as recovered, but were still quarantined.

Allice Kennedy, Roseville, had 1 animal affected with the plague, which was killed August 14.

Union County.—C. E. Winans, Salem, herd of 9 head. Had lost 2 animals up to August 5. The remainder were sick and in quarantine.

Louis E. Meeker, Salem, herd of 13 head. Five animals were sick on August 1, when the herd was quarantined. On January 2, having purchased another animal, he had 14 head. Three of these were chronic cases, and were ordered quarantined for 30 days longer.

J. O'Calighan, Salem, on August 26, had a herd of 9 head, with but one animal sick. Up to November 12 he had lost 5 animals, and had but 4 left. On January 20 he was visited by the State inspector, but refused to drive his cattle in from the field for examination. The officer, on threats of personal violence, ordered him to keep up the quarantine, and left without making the examination.

E. A. Bloomfield, Salem, herd of 4 head, 1 sick; quarantined August 26. Had one chronic case on January 1; quarantine continued.

F. Saltzmen, Roselle, herd of 3 head, 2 sick; quarantined September 3. On January 20, 1 animal was sick and the herd was still in quarantine.

Bergen County.—C. McMichael, Leonia, herd of 21 head; 5 sick; quar-

antined April 1; on July 11 had 2 animals sick, and on January 21 had but 5 animals left, 2 of which were sick; quarantine continued.

Christian Freund, Closter; herd of 10 head; 5 sick; quarantined November 11. The same report of this herd was made on November 19. It is still in quarantine.

Hudson County.—The disease exists in the following localities:

Stables Nos. 133 and 144 Essex street, Jersey City.

Jersey City Heights.—Mary Mullin, 106 Thorn street; J. Lewis, corner Hutton and Sherman streets; J. Platz, 899 Montgomery street; J. Gurrey, Hopkins street; Martin Staunton, Hopkins street; George Reed, 87 Germania avenue; J. Leddey, Nelson and Charles streets; J. Ryan, 25 Laidlaw avenue; Jonathan Meyer, 22 Gardner street; John Bosch, Congress and Hancock streets. These localities are all in quarantine.

Greenville.—B. O'Neil, Brittain avenue; William Shaw, opposite cemetery; Mrs. Corcoran. All quarantined.

Hoboken.—Benjamin Engle, 200 Newark avenue; John Torpey, 172 Grand street; V. Cohen, old small-pox hospital. (Mr. Cohen, having diseased animals, desired a permit to put a fresh cow in his stables; he was refused, but he stated to the officers that he should put her in any way. This he did, and I afterwards saw this cow in his stable suffering with the disease in its acute stage.) Michael Reynolds, 165 Grand street.

West Hoboken.—J. Claude, Cortlandt street; Harris Aaron, Newark street; H. M. Nass, Hollingen; Mrs. Schmidt, Hackensack plank road; B. Benjamin, Cusset street; —— Kuntzle, Blume street; Mrs. Schlooler, Blume street; Ernest Weiss, Demot street, —— Oldmeyer, Boulevard.

Secaucus.— —— Latenstein, county road; H. Fisher, Secaucus road; —— Loeffle, race course; Bryan Smith, race course; N. Wehlker, race course; H. Black, North Bergen.

DELAWARE.

The only information I have as to the prevalence of the disease in Delaware I received in the course of a conversation with Mr. George G. Lobdell, president of the Wilmington Car-wheel Company. His farm is located in Newcastle Hundred, about two miles from Wilmington. In 1858 he had a valuable herd of animals. During this year contagious pleuro-pneumonia broke out among some cattle on a farm about three miles from his place. Fearing the infection of his herd, he commenced to sell off his cattle as he could find purchasers, but before this was accomplished, and perhaps within four months, it reached his farm, and by spring he had but one animal left. For two years after this he was without cattle, but at this time he commenced to stock his farm again. About six years ago the disease was introduced into a herd kept on a farm about two miles from his place. His own cattle remained exempt until about two years ago, when they were again infected. Since then he has been using the fumes of burning sulphur, and has had no fatal cases. Mr. Lobdell informed me that some sort of a law had been passed by the State looking to a suppression of the disease, and that three commissioners had been appointed by the governor to superintend and enforce its provisions.

MARYLAND.

Although it has long been known in a general way that contagious pleuro-pneumonia existed among the cattle of this State, no effort on

the part of the authorities has ever been made to ascertain with any exactness the localities of the diseased herds.

On the 8th of March I proceeded to Baltimore, where I at once called upon Mr. William B. Sands, editor of the American Farmer, a gentleman who had greatly interested himself in this matter, and who gave me all the information in his possession as to the location and extent of the plague in the State, as well as kindly furnishing me with letters of introduction to the officers of the different agricultural societies throughout the State.

On the 9th of March I visited Hagerstown, the county seat of Washington County, where, on the next morning, I called upon P. A. Witner, esq., secretary of the county agricultural society. He said that he did not believe there was any disease in the county: that upon the day before there had been a meeting of the board of agriculture, at which there had been a good representation from all the different sections. Those present agreed that they had never known or heard of a case of lung plague in any part of the county.

I was next introduced to Mr. J. B. Bausman, a cattle dealer of this place. In the pursuit of his business he had been all over the county repeatedly, but had never known of a case of the disease. The drift of cattle in this place was entirely from Western Virginia through to Baltimore, never, so far as he knew, from Baltimore here. In his trade he feels very much the evils of the English embargo. It makes a difference to him of at least $10 per head in the price of his cattle. I then saw Dr. H. J. Cozens, an English veterinary surgeon, who had been located here for the past 15 years, and whose practice extends over the entire county. He had had a considerable experience with the lung plague in England, but had never seen but one case in this country, and that was many years ago, in Virginia. He is sure there is none in this county, nor has there ever been. Several other gentlemen from different localities were seen, but always with the same result. One farmer had a cow which he had recently bought that was coughing and not doing well. I visited her and found her suffering from tuberculosis.

In the afternoon I proceeded to Frederick City, the county seat of Frederick County. Here, upon the 11th of March, I called upon Mr. J. W. Baughman, secretary of the local agricultural society. He did not know of any diseased animals, but took me out to the court-house, where we saw and questioned a number of gentlemen from different parts of the county. None of them knew of any cases of this disease: they were very sure that had there been any unusual sickness they would have known of it.

I next saw Dr. P. R. Courtney, an English veterinary surgeon. He had been here but a comparatively short time, and had heard of nothing that caused him to think there was any of this disease in the county. He kindly offered to bear the matter in mind, and if any cases of the disease came to his knowledge he would let me know at once. Here, as in Washington County, the whole drift of cattle is from west to east.

In the afternoon I went to Westminster, the county seat of Carroll County, and with my letter of introduction called upon Col. W. A. McKellip, president of the county agricultural society. He was sure there was no disease of the kind in the county, but he said that it was quite a common thing at certain seasons of the year for cattle to be brought here from Baltimore. This I regarded as a very suspicious circumstance, and so asked for an introduction to some cattle dealer in town. This was kindly granted, and I proceeded to call upon Mr. Edward Lynch.

He said: "Farmers hereabouts generally make milk for the Baltimore market, and procure their cows from among themselves; but from the time that grass comes up until late in the fall of the year some of them are in the habit of feeding cattle; that the cattle for this purpose are generally bought at the 'scales' in Baltimore; that in this way, last fall, Mr. Samuel Cover, of Silver Run, this county, procured some stock which, after having been on his place for a short time, developed disease of some sort; some died, and some that were sick got well. Also, a Mr. Beacham, of Westminster, had had trouble of a similar nature for some time past." In a general way he knew that the farmers hereabouts were somewhat frightened about contagious pleuro-pneumonia.

March 12.—Drove to the farm of Mr. Samuel Cover, above referred to, at Silver Run, and found there three cases of chronic contagious pleuro-pneumonia. This gentleman stated that he had got the disease last fall through some steers that came from Southwestern Virginia, but which had stopped at the Baltimore stock-yards for some little time, at which place he had bought them. Some four or five weeks after he got them home the disease broke out among them. He had at that time some 80 head of neat stock. Of these 15 were sick. When the disease first showed itself he put all the sick animals in a building by themselves, and had all his stables thoroughly disinfected. This was kept up all the time, and the places repeatedly whitewashed. In all, 4 animals died, 2 of them the Baltimore steers; the other 2 were cows which he had had for some time. Mr. Cover further says that *now* when he gets cattle he always puts them by themselves in a building entirely away from his regular cow-stables, and hopes in this way to avoid any future outbreaks among his herds.

Returning to Baltimore on March 17, in company with Dr. Daniel Le May, a veterinary surgeon, I visited a herd of milch cows kept at a dairy in Woodbury, near Baltimore. Here we found 1 acute and 2 chronic cases of the plague. The man in charge said that he had got through with the disease, from which he had suffered greatly, some two months ago, by selling out all his sick animals. From here we went to another large dairy in the same neighborhood. The gentlemanly owner informed us that he had had none of the disease for some time; that his plan was to buy often and sell often. In this way he found that he could keep up his milking stock and keep rid of the disease. From here we visited a near neighbor living on the direct road to the city. In answer to questions this man said that he did not know if his neighbor (the one from whom we had just come) called it having the disease or not, but that he drove many a sick one past his house on his way to the Baltimore market. He (our present informant) was free to say that he followed this same practice himself, and had done so ever since he lost his first 8 animals. He supposed this was not right, but his neighbors did it, and so he did. Summer was invariably the worst time thereabouts. The next place visited was about 2 miles distant, and on a different road. The dairyman here had suffered greatly in the past, but thought that now, by *selling* the sick ones, he had nearly rid himself of the plague.

March 18.—We drove in several directions around the city and found the disease or its effects in all the herds except one that we visited.

March 19.—To-day we examined a number of the cow-stables in the city itself, in which many chronic and a few acute cases were found.

March 22.—Went to Harford County, where the disease was reported as existing in a number of different directions. However, we concluded

to visit the farm of Senator George A. Williams, whose herd of fine Alderneys have been suffering more or less from the scourge for the past two years. Here, among several chronic cases, was one that, although he had been sick for some time, was making no progress towards a good recovery. This animal the overseer consented to let us kill. The autopsy showed, well marked, the lesions of the disease. The infection here, as with all the other outbreaks hereabouts, came from Baltimore. At this point further investigations were given up for the present, and it still remains, in order to properly finish this report, to make an examination of the remainder of this State, the District of Columbia, and Virginia, in all of which places it is believed that contagious pleuropneumonia of cattle exists to a greater or less extent.

As a result of my investigations thus far, I find this ruinous foreign plague actually existing among cattle in the following States:

CONNECTICUT.—In Fairfield County.

NEW YORK.—In New York, Westchester, Putnam, Kings, and Queens Counties.

NEW JERSEY.—In Atlantic, Gloucester, Camden, Burlington, Ocean, Mercer, Monmouth, Middlesex, Hunterdon, Morris, Essex, Union, Bergen, and Hudson Counties.

PENNSYLVANIA.—In Philadelphia, Chester, Montgomery, Bucks, Lehigh, Cumberland, York, Delaware, Lancaster, and Adams Counties.

MARYLAND.—In Carroll, Baltimore, Harford, and Cecil Counties. The middle and southwestern portions of this State have not yet been visited.

No examination has yet been made in the District of Columbia or of the infected territory of Virginia, but, as the plague prevailed quite extensively in both of these localities last season, it will no doubt be found still in existence when the investigation takes place.

A map showing the extent of the infected territory accompanies this report.

Respectfully submitted.

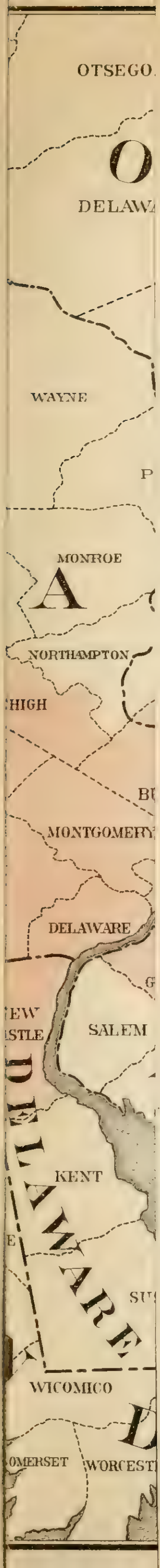
CHARLES P. LYMAN, *M. R. C. V. S.*

WASHINGTON, D. C., *April* 16, 1880.

CATTLE PLAGUE OR RINDERPEST.

HISTORY OF THE DISEASE.

The rinderpest (cattle plague, *pestis bovilla*) appears to have been carried from Central Asia to Europe as early as the fourth century, but the first exact description of this disease dates from the year 1711, two years after an extensive epizoötic outbreak of the same in most European countries. It is estimated that in the course of the eighteenth century, not less than two hundred million head of cattle were carried off by the cattle plague. In the beginning of the present century, Prussia, Schleswig Holstein, Saxony, and France, were visited by the plague, which was observed to have followed the movements of armies during the wars of the first Napoleon. In 1828, 1829, and 1830, during the Russo-Turkish and the Russo-Polish wars, the rinderpest was carried from Russia into Poland, Prussia, and Austria. In 1865 the plague appeared in Holland, and was carried thence to England. In both countries the disease carried off one hundred thousand head of cattle in the


OTSEGO
WAYNE
MONROE
NORTHAMPTON
MONTGOMERY
DELAWARE
SALEM
KENT
WICOMICO


MAP
SHOWING THE
STATES AND COUNTIES
IN WHICH
CONTAGIOUS PLEURO-PNEUMONIA
OF
CATTLE EXISTS.
BY DR. CHAS. P. LYMAN, V. S.
THE INFECTED COUNTIES ARE TINTED RED
NEW YORK
MASS.
CONNECTICUT
PENNSYLVANIA
OHIO
NEW JERSEY
LONG ISLAND
MARYLAND
DELAWARE
WEST VIRGINIA
VIRGINIA
ERIE
WYOMING
LIVINGSTON
ONTARIO
YATES
SENECA
CAYUGA
CORTLAND
CHENANGO
OTSEGO
SCHOHARIE
ALBANY
RENSSELAER
SCHUYLER
TOMKINS
CHAUTAUQUA
CATTARAUGUS
ALLEGANY
STEUBEN
CHEMUNG
TIOGA
BROOME
DELAWARE
GREENE
COLUMBIA
ULSTER
SULLIVAN
DUTCHESS
ORANGE
PUTNAM
ROCKLAND
WESTCHESTER
LITCHFIELD
HARTFORD
TOLLAND
WINDHAM
MIDDLESEX
NEW LONDON
NEW HAVEN
FAIRFIELD
SUFFOLK
QUEEN
WARREN
McKEAN
POTTER
BRADFORD
SUSQUEHANNA
WAYNE
CRAWFORD
FORREST
ELK
CAMMERON
LYCOMING
SULLIVAN
WYOMING
PIKE
MERCER
VENANGO
CLARION
JEFFERSON
CLINTON
COLUMBIA
LUZERNE
MONROE
SUSSEX
PASSAIC
BERGEN
LAWRENCE
BUTLER
ARMSTRONG
CLEARFIELD
CENTRE
UNION
CARBON
NORTHUMBERLAND
SNYDER
SCHUYLKILL
NORTHAMPTON
WARREN
MORRIS
ESSEX
UNION
HUDSON
BEAVER
INDIANA
CAMBRIA
BLAIR
MIFFLIN
JUNIATA
LEHIGH
HUNTERDON
SOMERSET
MIDDLESEX
ALLEGHENY
WESTMORELAND
HUNTINGTON
PERRY
DAUPHIN
LEBANON
BERKS
BUCKS
MERCER
MONMOUTH
WASHINGTON
CUMBERLAND
MONTGOMERY
LANCASTER
CHESTER
DELAWARE
OCEAN
BURLINGTON
CAMDEN
GREENE
FAYETTE
SOMERSET
BEDFORD
FULTON
FRANKLIN
ADAMS
YORK
GLOUCESTER
SALEM
ATLANTIC
CUMBERLAND
CAPE MAY
MONONGAHELA
PRESTON
ALLEGHANY
WASHINGTON
CARROLL
HARFORD
CECIL
NEW CASTLE
MARION
TAYLOR
HARRISON
MINERAL
HEMPSHIRE
MORGAN
BERKELEY
JEFFERSON
FREDERICK
BALTIMORE
HOWARD
KENT
QUEEN ANNE
KENT
TUCKER
BARBOUR
GRANT
FREDERICK
CLARE
MONTGOMERY
LOUDON
ANNE ARUNDEL
CAROLINE
LEWIS
UPSHUR
RANDOLPH
HARDY
SHENANDOAH
WARREN
FAIRFAX
PRINCE GEORGE
TALBOT
SUSSEX
BRAXTON
PENDLETON
FAUQUIER
PR WILLIAM
RAPPAHANNOCK
PAGE
CHARLES
CALVERT
DORCHESTER
WICOMICO
WEBSTER
ROCKINGHAM
CULPEPER
STAFFORD
ST MARY'S
NICHOLAS
POCAHONTAS
HIGHLAND
MADISON
ORANGE
KING GEORGE
WESTMORELAND
WORCESTER
BATH
AUGUSTA
ALBEMARLE
LOUISA
SPOTTSYLVANIA
CAROLINE
GREENBRIER

course of a few months. In 1867, Germany was again visited by the plague, which, however, was prevented by timely measures from spreading beyond the eastern provinces of Prussia. In 1870, soon after the outbreak of the Franco-German war, the rinderpest appeared in Germany in consequence of importations of cattle from Russia, and spread over Germany and France, following the movements of the armies. In the beginning of the year 1877, the disease was again carried into Germany by Russian cattle, and made rapid progress, because the imported animals, apparently healthy, but already infected, were allowed to reach the markets of Breslau, Berlin, and Hamburg, from which cities the infection was gradually communicated to other places. In Dresden the disease spread at once through the whole market. Towards the end of August, 1877, the rinderpest was reported by our consular officers as extinguished in the German Empire; but the danger of its reappearance in consequence of possible movements of cattle from the steppes of Southern Russia to the borders of Germany, though much lessened by the stringent sanitary regulations adopted by the Russian Government, is not regarded as entirely obviated.

Fleming, in his excellent work on Veterinary Sanitary Science, says that, in recent years, several of the most competent veterinarians have endeavored to ascertain the home of the cattle plague, but without much success. Unterberger throws much doubt upon Russia and its steppes being the source of the malady, and he asserts that it is a purely contagious disease in Russia-in-Europe, and also, perhaps, in the whole Russian Empire. It has been seen in Southern Russia, the Asiatic Steppes, in different parts of India; in Mongolia, China (south and west), Cochin China, Burmah, Hindostan, Persia, Thibet, and Ceylon. It is as yet unknown in the United States, Australia, and New Zealand. So far as Europe is concerned the geographical limits of the disease may be given as follows: "Beyond the Russian frontiers, and even in every part of that empire, the steppes excepted, the cattle plague is evidently a purely contagious malady. It is never developed primarily in Europe, either in indigenous cattle or in those originally from the steppes, and it has not yet been positively demonstrated that it may be primarily developed in the Russian Steppes; the most recent observations even tend to prove that in the European portions of these regions the affection is only present through the transmission of a contagium. Consequently, the plague is a malady which is perhaps primarily developed in the Russo-Asiatic Steppes—perhaps elsewhere—but is never seen in Europe except by the importation of its contagious principle."

In Russia the malady is known as *Tchouma*, *Tchouma reina*, and Fleming regards it as important to note the employment of this term by the Russians to designate the cattle plague. Reynal has pointed out that it proves, philologically, the region in which the disease originates, or rather permanently reigns—in the far east. History demonstrates that the appearance of the disease in early times in Western Europe coincided with the eruptions of the Mongols, and that the contagion accompanied armies; that the route it has followed in more recent years was that of the Huns, and that it remained with these people in the colony they founded on the shores of the Caspian Sea. The word *Tchouma* is used by the Mongols and Nomad Tartars of Central Asia to signify a malevolent deity—something of the nature of a vampire; and it has been adopted, with slight modifications, by all the people who have had any relations with that region.

CAUSES.

Nothing certain or definite as to the causes which develop the cattle plague are known. In Western Europe it relies solely for its introduction and diffusion to the presence of a contagium, carried either by animals suffering with the disease, those which have been in contact with them, or media of different kinds which are contaminated with the virus. Once introduced, it spreads from its point of introduction as from a center; each newly-infected animal becomes a focus whence the disease may radiate in every direction, and it usually attacks those animals which are nearest the foci. It spreads with more or less rapidity as the animals or vehicles charged with the contagium are moved about; even the air may, within a certain distance, be credited as an active agent in the diffusion of the deadly malady. The nature of the contagious matter (contagium), has also so far baffled all the efforts of investigators. Neither microscopic examinations nor chemical analysis of the tissues, blood, and mucus discharges of the infected animals, have led to the discovery of the principle of contagion. It is known, however, that from the very beginning of the disease a contagious matter is formed, which attaches itself to every part of the diseased animal. It is principally contained in the secretions of the mucous membranes, but, being volatile, attaches itself also to the urine, the dung, the blood, the skin, and the breath. It may be communicated to the atmosphere by exhalations from any part of the sick animal, or its carcass. Experience has shown that healthy cattle may be infected by coming near the sick animals, or near anything contaminated by their excrements or exhalations, without actual contact with them. The contagious matter has no effect in open air at a distance of twenty to thirty paces, because the air either dilutes or modifies it so as to deprive it of its power. But in cases where a current of air comes directly from an accumulation of infected matter, and also in inclosed spaces, the contagion may be carried to greater distances. Therefore, the disease may be communicated in a large stable to a healthy animal quite a long distance from the diseased one, or may be carried from one stable to another as far as a hundred feet apart. This happens only when the exhalations are carried over directly from one stable to the other, by a current of air so rapid as not to allow time for the air to dilute or modify the contagious matter. Where one stable is separated from another by a partition which is not air-tight, the contagion is very easily transmitted. Besides these direct means of infection, the disease may be carried to healthy animals indirectly, in many ways. For instance, objects which have come in contact with infected matter, may be carried to a distant place and there spread the disease. Porous substances, such as woolen clothing, wool, hay, straw, &c., are particularly liable to absorb the contagious matter, which may diffuse itself after some time in a distant place. Thus butchers, drovers, and other persons who visit infected stables, may carry the disease from yard to yard, and from village to village. In railroad trucks, the woodwork absorbs a considerable amount of the contagious matter, and, if not thoroughly disinfected, may communicate the disease to animals subsequently placed therein. The dung of diseased animals may spread the contagion to distant places, by being carried away on the wheels of vehicles or the shoes of persons. Dogs and cats may carry it in their fur and birds in their plumage. A small quantity of blood or dung on the sole of a shoe or on the tip of a walking-stick has sometimes been sufficient to carry the disease to a great distance. The modes of possible transmission are, in fact, so numerous as to render it, in many instances,

a matter of extreme difficulty to account for the cause of an outbreak of the plague.

The vitality of the contagious matter is variable, according to circumstances. Air is its most potent and reliable destroyer. Hay and straw which have lain above the stables of sick animals have been often used as fodder with impunity after an airing of twenty-four hours. Wool, impregnated with the mucus from the nostrils of sick animals, was found to be innocuous when thoroughly aired for five or six days. Stables and pasture-grounds will be thoroughly disinfected in a few weeks by the action of the atmosphere. In the same way clothing and other porous substances become entirely disinfected by airing. The stronger the current of air the more prompt its disinfecting action. On the contrary, if infected porous substances are not exposed to currents of air, the contagious matter is preserved for a long time. Closely-packed hay and straw, the woodwork and floors of closed stables, manure-heaps, packed-up clothing, &c., may remain infected for several months. A case is recorded of the rinderpest breaking out anew in a stable which had stood empty for four months, but had not been disinfected after a previous outbreak. The flesh and hides of carcasses which had been buried for over three months were found to be capable of infecting healthy animals.

Very high temperature has the same effect in destroying the power of the contagious matter as currents of air, but summer heat is effective only in so far as it promotes the drying up of the contagious particles, and renders them more volatile and more easily diluted by the air.

The contagious matter is not destroyed by cold, not even by frost; on the contrary, its power is preserved, as the drying up of the substances containing it is thereby hindered. Dung frozen through the winter spreads the contagion upon thawing in the spring.

All ruminating animals are liable to the rinderpest, but goats and sheep are less commonly and less severely affected by it than neat cattle. The disease does not affect non-ruminating animals, nor is it in any way dangerous to man.

The rinderpest breaks out generally on the fifth or sixth day from the time of infection, sometimes as early as the fourth, and frequently as late as the eighth or even ninth day. According to some observations, the period of incubation may extend to two or three weeks, but the instances of so protracted an incubation are to be considered as entirely exceptional.

The spread of the disease in a herd of cattle is usually slow in the beginning. Often when the contagion is introduced only a single animal is infected. This one, after the few days required for the incubation, becomes sick and commences to evolve the contagious matter, which infects one or more of the animals in the same stable or herd. Then, again, an interval of time elapses before the disease is developed in the new victims. As soon as several animals are diseased, the contagion spreads more rapidly, and many are attacked at the same time. Want of proper caution on the part of stable-men and other attendants is often the cause of an exceedingly rapid progress of the contagion, which is carried in their clothing from one end of the stable to another.

PHENOMENA OF CATTLE PLAGUE DURING LIFE.

Dr. J. Burdon-Sanderson, one of the commissioners appointed by the English Government to investigate this disease during its last invasion of Western Europe (1865), in speaking of the phenomena of cattle plague

and the general character and progress of the malady during the life of the affected animal, says that it is an essential or general fever, and that it can be shown, more clearly than in any human disease of the same class, that the disturbance of the system which is understood by the term fever may exist independently of local changes occurring in particular organs; and in this respect a fact new to pathology has been discovered, *i. e.*, that the increase of the temperature of the body, which is the one and only symptom which all fevers have in common, exists for several days before any other derangement of health can be observed. Although constitutional or general in its origin, the disease is attended with local alterations of structure, some of which are so constant and invariable that no definition of the malady can be complete which fails to recognize and include them. Dr. Sanderson says:

The observations and experiments which have been made, so far as they have been carried out, relating to the phenomena of the disease during life, lead to the conclusion that, with reference to the *constitutional* effects, the disease consists in (1) increase in temperature of the body; (2) increase in the elimination of urea by the kidneys, indicating increased disintegration of tissue; (3) alteration of the physical and chemical qualities of the blood, manifesting itself in impairment of its coagulability and in a marked tendency to capillary hemorrage; and, lastly, (4) a general septic condition of the fluids and tissues, in virtue of which they are unnaturally prone to decomposition even during life.

With reference to its *local* manifestations, the disease appears to be distinguished by an alteration of the superficial structures of the skin and mucous membranes, consisting (1) of minute capillary congestion (*hyperæmia*) of the vascular layer (*corpus papillare, membra propria*); (2) of increased as well as perverted growth of the structural elements, naturally developed at its free surface, this change leading to thickening, softening, disintegration, or detachment of the epidermis or epithelium respectively, but very rarely, if ever, to ulceration or loss of substance in the deeper tissue; and, lastly, (3) of increased and perverted activity of the secreting glands of the skin and mucous membrane, resulting in mucus or sebaceous discharges.

Cattle plague belongs to that class of fevers which is distinguished by marked uniformity in their development and duration. In this respect it resembles small-pox more than any other disease which affects man. The resemblance is, however, generic rather than specific, for in cattle plague the essential phenomenon of small-pox—the eruption—is wanting.

In fatal cases the progress of the disease is divided into three stages. The first stage, comprising the first and second day, is marked by no appreciable change in the condition of the affected animal, excepting increase of temperature. During the second stage, which comprises the third, fourth, and fifth days of the disease, its symptoms develop themselves in quick succession. The appetite fails, rumination ceases, the daily excretion of urea by the kidneys is augmented, while the animal loses strength and weight. The last stage, that which immediately precedes the fatal termination, is characterized by the rapid decline and cessation of the vital functions, and, above all, by sudden sinking of the temperature of the body.

The leading phenomena of the disease may be described as follows, according to the order of time in which they occur:

During the first two days, as has been already stated, there are no symptoms excepting elevation of temperature, so that the time of commencement of the disease can be determined only by the thermometer. But on the third day an eruption, exactly resembling that of thrush, appears on the gums and inside of the lip. The eruption usually commences by the formation of groups of very minute raised points or dots on the surface of the mucous membrane, which are usually first seen a little below the corner tooth on each side. This appearance is in many cases neither preceded nor accompanied by any redness of the surrounding surface, but occasionally a slight blush is pecreptible near the elevation. The animal continues to ruminate, and its appetite, pulse, and breathing are unaffected.

On the next day the eruption above described on the mucous membrane of the mouth is found to have extended. The whole of the surface between the lower lip and the gum is studded with raised groups of elevations, while those previously observed below the corner teeth have coalesced, so as to form patches. The animal is listless, takes less food than usual, and ruminates irregularly, but the pulse and respiration are unaltered. On this day alterations may often be observed on the cutaneous surface. In the neighborhood of the vulva and on the inside of the thighs the skin is found to be greasy, as if smeared with an unctuous substance.

On the fifth day the animal is obviously ill. The head hangs down, the ears are thrown back, and the attitude and movements are suggestive of depression. The

pulse is sensibly weaker, and often the artery feels hard and thread-like under the finger, expanding scarcely perceptibly with the systolic impulse. The breathing is sometimes almost natural, but more frequently begins to be oppressed and irregular.

With the sixth day the alterations of the mucous membrane of the mouth attain their full development. The under lip is covered with a crust of white opaque material (consisting of epithelium, mixed in most instances with the filaments and spores of a hyphaceous fungus), which is either confluent and continuous or in patches. This crust is usually of the consistency of cream cheese, in which case it adheres so slightly to the surface on which it lies, that the slightest touch is sufficient to detach it. Wherever it is so separated, the bright red vascular surface of the mucous membrane (*membrana propria* of anatomists) is exposed, raw looking, but free from ulceration. Similar appearances are observed on other parts of the mouth, particularly on the upper gum, on the dental pad, on the cheeks and hard palate, and on the lower surface of the tongue near its lateral margins.

During the sixth day the leading symptoms are those which arise from *diminished* contractile power of the heart and voluntary muscles. The affection of the heart is indicated by increased feebleness and frequency of the pulse, and by the extinction of the præcordial impulse; that of the voluntary muscles by the attitude and movements of the animal, which are so indicative of adynamia that many writers have been misled by them into the belief that in rinderpest there is a special paralytic affection of the spinal nervous system. At the same time the mechanism of the respiratory movements is modified in a remarkable and characteristic manner, the modification being dependent partly on the cause above referred to, and partly on pathological changes having their seat in the air passages. The alvine discharges, which during the previous progress of the disease were firmer and harder than natural, now become soft, and eventually liquid and dysenteric. The temperature of the body, which up to the fifth day has gone on increasing, rapidly sinks to below the natural level; this loss of animal heat being attended with a correspondingly rapid diminution in the quantity of urea excreted by the kidneys.

Death usually occurs during the seventh day. It is not preceded by convulsion or any other symptoms worthy of special notice.

SYMPTOMS.

One or two days before any other change occurs in the condition of the infected animal there appears an increase of temperature, which is most readily detected by means of a thermometer introduced into the rectum. The temperature is found to have risen by two to four degrees Fahrenheit, from the normal temperature of 102°. At the same time symptoms of fever are observed, such as shivering, muscular twitchings, dryness of the skin, a staring coat of hair, an unequal distribution of temperature throughout the body, and changes of temperature, which are particularly noticeable at the base of the horns.

A very important and characteristic symptom at an early stage of the disease is a peculiar alteration of the mucous membranes. This alteration is very soon noticeable in the vagina of cows, which becomes spotted or striped with red. The next day small yellowish-white or gray specks are clearly seen on the red spots and stripes. These specks are formed by the loosening of the cuticle, which can be rubbed off or detached by the finger, leaving in its place a dark-red depression. The same red spots and stripes and yellowish or gray specks appear in the mouth and nose of the sick animals of either sex.

Fleming, in his work on *Veterinary Sanitary Science and Police*, gives the following description of the peculiar eruptions of the mucous membrane and the skin:

With regard to the mucous membranes and skin, there is much that is not only interesting, but of the greatest practical importance in the way of diagnosis. The development of the symptoms previously enumerated are soon accompanied by anatomical and functional alterations of these membranes, but especially of that lining the vagina and the digestive and respiratory tracts. The vulvo-vaginal membrane is most frequently that which exhibits these changes. It is more or less infiltrated, and of a brown, brick-red, or mahogany color, which is either disposed in streaks, patches, or diffused; and there may be small sanguine extravasations, variable in number.

This abnormal color, which is more particularly due to venous injection, has in calves and heifers a greater diagnostic value than in cows, as it is observed, though in a less degree, in animals which are near calving, as well as those which have lately calved.

This symptom, however, is not always observed at the commencement of the disease, but may only appear at an advanced stage. Twenty-four hours after its appearance there are usually seen on the red surfaces small yellow or grayish and slightly salient patches, which might be mistaken for little flakes of mucus, though they are really composed of masses of altered epithelial cells. They adhere but slightly to the dermal surface of the membrane, or are merely lying on it; they are quickly removed by friction, or thrown off by the alterations going on, leaving excoriations corresponding to the situation they occupied. At this period, or a little later, there flows from the vulva a variable quantity of clear or ropy mucus, which, in drying, adheres to the neighboring parts.

While this alteration is going on in the vaginal membrane, or before or after, other analogous changes are observed in the other visible membranes. That of the mouth is more or less hot, and generally, or in patches of variable extent, assumes a deep red, livid, or dark-blue tint, particularly about the gums, though the presence of pigment may conceal this coloration. Ordinarily the derm of this membrane and its epithelium are tumefied at certain points, and the adhesion of these two layers to each other is diminished. In a very brief space there appears at first on the lips and gums, afterwards on the palate and borders and sides of the tongue, little whitish-gray or yellowish elevations the size of a pin-head, due to the proliferation, infiltration, and fatty degeneration of the epithelium in these localities. The number and dimensions of these elevations increase, and sometimes they join each other; their connection with the derm becomes loosened, and soon—frequently within twenty-four hours—the slightest rubbing will remove them in the form of a soft gray mass not unlike bran: they are also thrown off by the morbid process going on. However removed, the derm upon which they were formed is exposed, and in this way are produced those excoriations whose sharply defined bright red color contrasts strikingly with the livid membrane surrounding them. These are the "pestilential erosions" of Kausch, so named from the veterinarian who first described them. These epithelial alterations occur, at times, at the base of the papillæ of the cheeks as early as the appearance of the first morbid symptoms, though, as a rule, it is only towards the second, third, or fourth day that they are most marked.

The secretion of saliva is increased and flows in large viscid streams from the mouth. The nasal mucous membrane is also greatly injected from the commencement of the affection, and becomes infiltrated and swollen; soon after it becomes uniformly pale, or in such a manner as to leave injected streaks or patches; petechiæ also appear in variable number. Towards from the second to the third day, on examining this membrane closely, it will be noticed that there are the same pulpy or caseous epithelial collections observed on the membrane of the mouth and the vulvo-vaginal membrane, and which, when thrown off, leave the derm exposed. In about twenty-four hours after the more evident signs of the disease have appeared a nasal discharge manifests itself; this is at first serous and transparent, but ere long becomes a thick mucus or muco-purulent yellowish matter, which may be mixed with blood, and disagreeably fetid. In drying around the nostrils it forms thick crusts.

The conjunctiva of the eyes are also infiltrated and deeper colored—particularly about the free border of the nictitating membrane—than usual; but this coloration most frequently disappears in the course of the malady, and this membrane is then pale. The secretion of tears is very copious, and, flowing in abundance down the face, by their acridity they may depilate and erode the skin. A thick muco-product fluid collects in the inner canthus of the eye and behind the membrana nictitans, and as the animal becomes emaciated and the eye-ball sinks towards the bottom of the orbit this accumulates.

The skin, which is usually lax shortly after the invasion of the malady, in the majority of cases and in many epizootics, becomes the seat of a diversely characterized eruption, which has been at one time described as squamous, at another papular, vesicular, or pustular, and again as erysipelatous. This cutaneous manifestation more especially appears in those parts where the integument is thin, though it may also invade other regions or even affect the entire surface of the body. The udder and particularly the base of the teats, the scrotum, the margin of the nostrils, the lips, and the vulva, the perineum, and the internal aspect of the thighs, are the localities for which it seems to have a special predilection, but it may likewise be often noted between the jaws, on the shoulders, neck, and withers. The extent and intensity of these exanthemata are very variable. At times they accompany the ordinary symptoms, while at others the eruption is coincident with an intense febrile reaction which lasts for some days and increased temperature of the skin where it is about to appear, with, in certain instances, a more or less abundant transpiration.

This exanthema of cattle-plague consists of (1) a proliferation and abundant disqua-

mation of the epidermis, accompanied by shedding of the hair; (2) the production of small papulæ or nodosities, from which exudes a yellow viscid fluid which, in drying, forms with the hair crusts of variable thickness; (3) the eruption of little vesicles about the muffle, whose contents agglutinate the hairs and gives rise to brownish-yellow crusts; (4) the formation of pustules (the so-called "variola" of Ramozzini) the size of a millet seed or small pea, frequently confluent, and when ruptured and their contents desiccated, producing friable, yellow, or brown crusts, which adhere very slightly to the skin. The duration of the eruption is variable, but in general it does not entirely disappear until from two to four weeks after its manifestation.

In some epizootics erysipelatous tumors have been remarked about the neck, dewlap, or flank. Gas is also developed sometimes in the subcutaneous cellular tissue, ordinarily in the region of the loins, shoulders, sides, or neck, and in rare cases over the entire surface of the body; its presence is recognized by a more or less voluminous tumor, which crepitates on manipulation.

The next day after the appearance of the peculiar eruption upon the mucous membranes, there is a disinclination to eat and ruminate, and with cows a diminution and soon a total absence of milk.

Two days after the manifestation of the above-described symptoms, marked changes in the general appearance of the diseased animal are apparent. It lies down very frequently; when standing it draws the hind legs forward as if suffering from colic. The look is distressed, the head drooping, the ears hanging, the breathing oppressed; the pulse becomes rapid and weak, the discharges from the eyes, the nose, and the mouth become thick and purulent, the breath fetid. The iris, which at the commencement of the fever is generally inflamed and cherry red, resumes its natural color with the increase of secretions from the lachrymal duct. Cows far advanced in pregnancy generally calve in this stage of the disease.

On the second or third day diarrhea sets in. The feces, at first thin and watery, then thick and slimy, are filled with detached masses from the mucus surfaces, very fetid and more or less tinged with blood. When the diarrhea has lasted two or three days the disease advances with rapid strides. The animal is so weak as not to be able to rise, the evacuations of excrements are involuntary, the breathing is uneven and rapid, the beatings of the heart are no longer perceptible, the pulse becomes very feeble and the temperature rapidly falls. Death usually occurs on the fifth day from the first visible signs of the disease. Sometimes the course of the disease is so rapid as to reach its culmination within two days.

On the average, 70 to 75 per cent. of the diseased animals die. Those that survive have not had the disease in its most malignant form. Once convalescent the animals recover very fast, but the diarrhea continues for several days after the disappearance of all other symptoms.

In summer, when the cattle are grazing, the disease is less severe than in winter, when they get dry fodder and are kept in close stables.

The symptoms and progress of the disease are the same with goats and sheep as with neat cattle, but the percentage of fatal cases is somewhat less.

Many of the symptoms of rinderpest occur in the lung disease (*pleuro-pneumonia*), the malignant catarrhal fever, and the mouth-and-foot disease. The lung disease is distinguished from the rinderpest by the absence of the characteristic eruptions upon the mucous membranes; the malignant catarrhal fever, by the dimness of the transparent cornea, which in the rinderpest remains clear; the mouth-and-foot disease, by the ulceration of the foot, the less degree of fever, and its peculiarly rapid spreading from one animal to entire herds.

PATHOLOGY OF THE DISEASE.

Among the lesions observed after death there are several, though no more constant than several of the prominent symptoms, that materially assist in establishing a proper diagnosis. The age and general condition, the state in which the animals were kept before they were affected, their breed, the character and intensity of the disease, all appear to have some influence on the seat and seriousness of the lesions. These vary according to the period at which death takes place.

Fleming says that if the animal is killed at the commencement of the malady, and the symptoms have been comparatively mild, there will nevertheless be found, on examination after death, such alterations in the mucous membranes as congestion and ecchymoses. The latter are more particularly observable on the free border of the mucus folds in the fourth compartment of the stomach (true stomach) and around the pylorus, although they also exist to a less degree in the small intestine, and often in the vagina. When, however, an animal has died from the disease, or been killed when it had attained a certain degree of intensity, the changes are more marked, the body becomes quickly inflated after death, and sometimes even before death occurs. The rectum is elevated and its lining membrane is tumefied and of a deep red color; the tail and hinder extremities are more or less paralyzed during life, and are therefore usually soiled by the feces. The skin exhibits the characteristic eruption, and in those places where there are neither glands nor hairs, as on the teats, it is injected in irregular patches of variable dimensions; the epithelium is thickened, soft or friable, and the integument is often cracked. On removing the skin the vessels which are cut are generally filled with a dark-colored fluid blood, and the flesh is red, blue, or violet-tinted. The peritoneum in some cases may be slightly injected or ecchymosed in patches. The whole of the intestines are generally greatly distended with gas, and in some cases the small intestine may be reddened.

In the interior of the digestive canal are found the most marked evidences of the disease, though they are not always constant and equally intense in every portion of the mucous membrane. In the mouth, pharynx, true stomach, small intestine, and rectum, they are most frequently present. They are least conspicuous and often absent in the œsophagus, the three first compartments of the stomach, and in the cæcum and colon. They may be so trifling as to resemble the lesions of a slight catarrh, while in other instances they are unmistakable and pathognomonic.

In the mouth and pharynx are observed the alterations in the lining membrane and the epithelial changes. It is chiefly where there has been much friction or local irritation that they are most exaggerated, and deep erosions, with loss of texture of the derm of the mucous membrane, may be noted. The œsophagus is rarely affected, though it is not always exempt. In the rumen the quantity of food may be found a little larger than usual. The epithelium on the mucous membrane lining it and the next compartment may be more easily detached than in a healthy state, and a microscopical examination of the cells proves them to have undergone a similar change to those of the mouth. The mucous membrane in these compartments is also frequently injected in a general manner, though more deeply in some places than in others. It is not rare to find on this membrane round, oval, or irregular-shaped eschars, disposed separately or in groups, and varying in color from a dark brown to a greenish hue. The elimination of these eschars takes place gradually from around their well-formed borders, and cicatrization afterwards

RINDERPEST.

Skin of udder on the sixth or seventh day, showing, in addition to the usual eruption, patches of redness on the teats.

A Hoen & Co Lithocaustic Baltimore

RINDERPEST.

Skin of the udder showing eruption in more advanced stage of the plague.

A. Hoen & Co Lithocaustic, Baltimore

Lips and gums, showing apthous condition.

A. Hoen & Co. Lithocaustic. Baltimore.

Roof of mouth, showing excoriations.

A. Hoen & Co. Lithocaustic. Baltimore

Report Commissioner of Agriculture for 1879. Plate V.

Tongue and throat, showing thickening of epithelium with excoriation and congestion.

A. Hoen & Co. Lithocaustic, Baltimore.

Report Commissioner of Agriculture for 1879. Plate VI.

Surface of lungs showing interlobular emphysema, extending in some places into the sub-pleural tissue.

RINDERPEST.

Portion of fourth stomach of cow, about eighth day of cattle Plague, showing patches of ecchymosis and deep ulcers.

A Hoen & Co Lithocaustic Baltimore

Rectum and Anus, showing deep congestion.

A Hoen & Co Lithocaustic Baltimore

occurs, even in cases which have a fatal termination. Submucous extravasation is probably the cause of these gangrenous patches. Around them the tissues are infiltrated, and more or less injected, while beneath the texture is injected or ecchymosed, and red or green in color.

The third compartment sometimes contains food, which is hard, dry, and friable; at other times it is soft and pulpy. In the first case, the epithelium of the leaves is readily detached, and adheres to the cakes of aliment removed from between them. This epithelium also exhibits granulo-adipose degeneration. The leaves themselves are injected wholly or partially, and ecchymoses and eschars may be present in them; they are also easily torn. In the fourth compartment and small intestines the contents are at first normal; but they soon change, and there is found a small quantity of thick, yellow, brown, or even blood-colored fluid. The mucous membrane is covered by a viscid, grayish-yellow, or reddish mucus. The cæcum and colon at this period contain a frothy mass of a brownish, sometimes sanguinolent, fluid. The rectum has a thick viscid mucus adhering to its inner surface. If the disease pursues its course, the débris detached from the intestine is mixed with exudations and extravasations to form a viscid, albuminoid, whitish-yellow, brown, or red fluid, in which are shreds and the detritus from the membrane.

When an animal has been killed in the early stages of the disease, and the mucus has been carefully removed from the mucous membrane of the stomach, it is found that the surface of the latter is irregular, and that its tissue is infiltrated and injected to a degree corresponding with the seriousness of the attack and the stage the malady has reached. The abnormal color, varying from a brick-red to a reddish brown, is generally diffuse, but is most marked at the pyloric portion, attaining its maximum of intensity towards the free borders of the folds. Submucous extravasations are also frequently met with in this part, differing in size from a fine point to a large patch. In the small and large intestines there also exist, at this period, analogous alterations; but, while the redness of the abomasum is usually diffuse, in the small intestine it generally appears in the form of transverse striæ, which are crossed by lighter-colored longitudinal streaks, this intercrossing forming a somewhat regular pattern. These extravasations are common in the small intestine, but the infiltrations and exudations are not so frequent in the abomasum. In the duodenum the alterations are usually more intense than in the remainder of the intestine, and it is not rare to find in it a very marked diffused redness and much sanguine effusion. The congestion is often greatest around the solitary glands and Peyer's patches, whose volume is more or less increased. Frequently the areolated aspect of these patches is most conspicuous at the termination of the first period. The same lesions are found, but in a less degree, in the large intestines. In these the most salient portions, such as the borders of the valvulæ, are the parts which are the most deeply colored and most extensively ecchymosed. The infiltration is greatest if diarrhea has not been present.

In cases where the disease has made considerable progress, the lesions are still more characteristic. The mucous membrane of the abomasum and intestine is deeper colored, often blue or black, and in the duodenum of animals which have succumbed, it may even be uniformly black, while the petechiæ and ecchymoses are more numerous. In the abomasum, but oftenest in the intestine, towards the fifth day of the disease, there appears a pigmentation, varying from a bright gray to a slate color, or even darker, and which takes the place of the abnormal color due to the blood. This appearance is first noticed in the rectum, and

in the intestines generally its tints seem to be related to the intensity of the blood coloration, of which these parts have been the seat. It is therefore in the duodenum, and especially near the pylorus, that it is deepest-tinted and most extensive. In the duodenum it is diffuse, but in the remainder of the small intestine it is limited, as a rule, to a double series of perpendicular zones more or less incomplete, and in the rectum is usually in the form of longitudinal lines. This coloring matter is deposited in the most superficial layer of the mucous membrane, and is constituted by minute irregular granules, which, according as they are disposed separately or in clusters, give rise to the different shades. Around the orifices of Brunner's glands, and in the texture of the villi, this deposit appears to be most localized.

The epithelium of the fourth compartment of the stomach rapidly undergoes changes analogous to those observed in the mouth. Their intensity depends upon the part examined, as well as the gravity of the attack and its stage. In the first and last portions of the small intestine in the cæcum, in the first section of the large colon, and in the rectum, they are generally more developed than elsewhere. In mild cases the epithelium, though not yet detached, is always less adherent to the derm than in health. In more serious cases this layer is found completely detached over a considerable surface, and especially in the small intestine. The excoriations thus produced vary both as to extent and number, and are generally covered by a gray, red, or dark colored viscid mucus. The matter is tenacious, and adheres firmly in flakes to the membrane. The extent of these flakes is generally from a quarter to two inches in length. The color is gray, yellow, red, brown, or black; their free surface is smooth, and more or less convex; their variable consistency is less at the border than the center; the membrane beneath them is injected and spotted with small extravasations, and their margin, in consequence of the retraction of the flake, is separated for a short space from the border of the erosion.

The mortification which may invade the intestinal wall does not usually go beyond the mucous membrane. In rare and very severe cases it extends to the submucous connective tissue, or even to the muscular layer. The liquefaction of the mortified patches causes a loss of substance in the membrane, and these places are designated "excoriations" or "erosions," according as the derm remains intact or not. Their number is as variable as are the patches. The viscid masses covering the surface of the intestine, as well as the flakes, are produced by the utricular glands of the gastric and intestinal mucous membrane, which are greatly altered and tumefied.

Peyer's glands undergo alterations of a particular character. They lose their epithelial covering, and, in the majority of epizoötics, undergo changes analogous to those of the solitary glands; though in other epizootics they are rarely affected, and when they are the lesions are not always equally marked. Sometimes they are merely covered with a mucus layer, like the other parts of the intestine, and are injected; at other times they are more salient than usual from tumefaction, and they then may contain contents like that of the solitary glands; again, they may be covered by a croupal exudation or false membrane, several lines in thickness, and gray, yellow, red, or blue in color, adhering by its central part to the mucous membrane. The presence of these patches is not a constant feature in the pathological anatomy of the disease; in certain epizoötics it is almost always present, while in others it is exceptional. Among the conditions which appear to have an influence in its production only one is known, and that is the condition of the animal

before infection; if it has been well nourished these deposits are most likely to be present.

The prominent alterations in the glands of the mucous membrane appear to consist in an exaggerated proliferation of their cell elements, accompanied by a prompt granulo-adipose destruction of the newly-formed cells. The liver is seldom much altered, but the gall-bladder is very often distended with bile, and its mucous membrane is in somewhat the same condition as that of the intestines. The mucous membrane of the air-passages is greatly altered. That lining the larynx, the trachea, and also the bronchia is injected and marked by extravasations which, particularly in the trachea, appear in the form of longitudinal striæ.

The lungs are frequently emphysematous (interlobular) to a degree corresponding to the intensity of the malady. This condition is chiefly noticed about the borders of the lungs and in the mediastinum, and, passing along the large blood-vessels toward the lumbar region, it may reach the loins. The lungs are also occasionally œdematous. The pleura, like the peritoneum, is occasionally congested in places, and even ecchymosed. The heart is usually flabby, dark or clay colored, and friable, and at times there are subendocardial extravasations towards its base; the blood is darker colored than in health, and coagulates imperfectly or not at all. The kidneys may be tumefied, congested, and more friable than usual. The bladder is rarely empty, but generally contains a quantity of urine, which may be pale, dark colored, or muddy, and have suspended in it shreds of epithelium. Its mucous membrane may also be congested and ecchymosed, and covered with viscid mucus. The vulvo-vaginal mucous membrane presents a very marked redness, which generally extends to the cervix of the uterus. As in the mouth, there are little elevations of altered epithelium on this membrane, with erosions covered by viscid matter. The udder, frequently congested, sometimes contains a small quantity of thick milk.

According to Reynal, the latest observations on the pathological anatomy of cattle plague are those of Damaschino, who has made a complete study of the histological alterations occurring in the disease. This investigator states that the ulceration of the mucous membrane is due to an unique process, which presents a great resemblance to that of pharyngeal diphtheria of man. At the commencement, the lesion consists in an exaggerated production of epithelial cells, which are infiltrated with an amorphous substance, become deformed, throw out multiple prolongations, and acquire an abnormal adhesion, which finally gives them a pseudo-membranous aspect. But beneath these false membranes the young epithelial cells do not submit to the same alterations. Instead of the prolongations adhering to each other and becoming matted together, they are the seat of a purulent transformation, whence results less adhesiveness, and soon the casting off of the pseudo membrane. At this moment ulceration commences, and as these tissues are softened it happens that there is found implanted on this surface fragments of hairs, which are recognized by the microscope. The loss of substance is not always superficial. On the tongue, sometimes, the lesion ceases at a portion only of the thickness of the papillæ, but in other cases it extends throughout their texture. In the stomach it is often deeper, comprising a portion of the substance of the glandulæ, and even the entire thickness of the mucous membrane to such a degree that, without the presence of a thick layer of adipose tissue at these points, the stomach would frequently be found perforated. On the surface of these ulcerations the adipose tissue exhibits all the characters of inflammation

proper (nuclear proliferation in the conjunctival parietes). In two cases there was found a lesion of the renal and hepatic parenchyma, consisting in a granular degeneration of the glandular elements. In the liver, the lesion, as is usual, showed a predilection for the periphery of the lobules in the vicinity of the vena portæ; there the cells were found in a very advanced stage of granular degeneration. The epithelium of the kidneys, more especially, showed the peculiar tumefied troubled appearance already indicated, though the granular condition was less marked. The muscular alterations consisted in the presence of numerous elongated bodies, very abundant in the right side of the heart, and incontestably situated in the substance of the muscular fiber. These bodies are blunt at one end, pointed at the other, and are composed of a regular mass of cylindrical cells lying together in such a manner that at the pointed extremity there is only a single cell, at the obtuse end two cells, and in the other part sometimes two, sometimes three cells, clustered on a given segment. It is surmised that these minute bodies are entozoa in their primary stage of development.

MEASURES FOR THE PREVENTION AND EXTINCTION OF RINDERPEST.

There being no remedy known for this disease, human intervention in dealing with it has thus far been necessarily restricted to measures for its prevention and extinction. Most European governments have passed laws and prescribed regulations for the purpose of protecting their repective countries from the invasions of the plague, and for its speedy extirpation on the occurrence of an outbreak. Of all these enactments the regulations now in force in the German Empire are considered as the most complete embodiment of the results of experience and scientific investigation in regard to this subject. The full text of this law will be found in Special Report No. 22, recently issued by this Department.

EXPERIMENTS WITH DEPARTMENT SEEDS.

A condensed statement of the results of experiments with seeds distributed by this department is given below:

WHEAT.

Arkansas.—Marion County: Victor—"Extra. Every farmer in this section wants the Victor." Yellow Missouri, several good reports. Pulaski County: "Some of the heads 10 inches long and well filled; delighted with this wheat." Drew and Stone Counties: "Entirely free from rust," and "quality superior."

California.—Los Angeles County: Sherman—"Fifty bushels per acre; first-rate; on land peculiarly liable to rust it stood the test perfectly." In Inyo, Lake, Lassen, San Diego, San Luis Obispo, Sonoma, and Humboldt Counties, Mold's White Winter yielded from 23 to 54 bushels per acre; quality excellent. Less favorable reports from other counties are attributed mainly to causes having no particular reference to this variety of wheat, such as *late sowing, mice, birds*, &c. There are no indications of a liability to rust. Returns from California, Oregon, and Washington Territory lead to the conclusion that the "Mold Wheats" will be of great value throughout the wheat-growing regions of the Pacific slope.

Colorado.—Larimer and Weld Counties report heavy crops of Improved Fife (spring wheat) from seed sown in February and March; quality excellent. Bent County: Mold's White Winter—"Thirty-one and a half bushels per acre; good. Boulder County: Mold's Red Winter—"Thirty-five bushels per acre; large and plump."

Dakota.—Lawrence County: Fultz—"Sown May 1; one quart produced one bushel; quality No. 1." Improved Fife is a favorite. Winter wheat has generally failed.

Georgia.—Floyd, Jones, and Upson Counties show a yield of 15 to 18 bushels per acre of Midge-Proof. The quality is reported good, and no reference made to rust. In Henry and Lowndes Counties the same variety was destroyed by rust. Black Bearded, or Centennial, in Jackson, Sumter, and Union Counties has yielded 20 to 22 bushels per acre of beautiful grain; damaged in one case by smut. White Australian—Meriwether County reports a heavy yield of fine grain, and but little affected by rust. In Polk and Sumter Counties it rusted badly. In Dooley, Jackson, and Pulaski Counties the yield ranged from 12½ to 30 bushels per acre; quality excellent, and no rust reported. Mr. George R. McKee, Valdosta, Lowndes County, writes, April 21, 1880:

> I have been trying experiments with wheat for three or four years, hoping to get something that would prove a success. I have made fair crops from seed grown here, but this season everything, that which was acclimated as well as the department seed, was a total failure, the *rust* destroying the crop. I must give it as my opinion that wheat planted here is generally wasted. Seed from Nicaragua or some place of the same latitude might do, but all northern-grown wheat will rust.

Fulton and Pickens Counties report favorably on Silver Chaff. In one case a yield of 34 bushels per acre is recorded. No mention of rust. Catoosa County: Yellow Missouri shows "a vigorous growth of bright, clean straw and heavy yield of excellent grain." In Baker County the same variety was entirely destroyed by rust.

Idaho.—Nez Perces County: Victor Winter—"Sown October 5; harvested August 10; 46 bushels per acre; superior wheat."

Illinois.—De Kalb, Edwards, Montgomery, Ogle, and White Counties give moderately favorable reports on Silver Chaff, the greatest yield reported being 27 bushels per acre. Many reports agree in putting Fultz at the head of the list in Illinois.

Indiana.—German Amber and Silver Chaff have done well in several counties. The almost universal testimony is in favor of Fultz, notwithstanding the objections of the millers.

Iowa.—Improved Fife is well spoken of in Shelby and Henry Counties. All varieties of winter wheat have been badly winter-killed in a majority of counties from which reports have been received. In sections where winter wheat is grown, Fultz and Clawson have the preference.

Kentucky.—Elliott, Jefferson, Montgomery, Morgan, Monroe, and Oldham Counties give good reports on Silver Chaff. The yield in one case was 50 bushels per acre. Lewis and Letcher Counties report 30 to 50 bushels per acre of Washington Glass. Jefferson, Johnson, and Lewis Counties show excellent results with Clawson. Fultz seems to be the favorite in a majority of the counties.

Louisiana.—All varieties failed on account of rust.

Maine.—Franklin County: Average yield of Fultz on three farms, 28 bushels per acre. "Entire success." Fultz sown in spring has not done as well as Lost Nation. The latter is the favorite variety of spring wheat.

Maryland.—One report, from Wicomico County, shows a yield of 27

bushels per acre of Silver Chaff. Among the older varieties Fultz is most in favor.

Michigan.—Reports from several counties show that Silver Chaff has the preference among the newer varieties, and that the Clawson is grown more extensively than any other.

Minnesota.—The Improved Fife has proved successful in a great many cases. It is thought that it retains the good qualities of the old Fife, and yields better.

Montana.—One report from Custer County shows a yield of 38 bushels per acre of Improved Fife.

Nebraska.—Improved Fife is particularly adapted to a prairie country, where high winds prevail, on account of its vigorous growth and stiff straw.

New Jersey.—Morris County makes a very favorable report on Silver Chaff. "Grain large and plump; quality excellent."

New York.—Richmond County: The Silver Chaff is thought to be a very valuable acquisition. A majority of reports received show that the Clawson is more extensively grown than any other.

North Carolina.—Many reports on Yellow Missouri are very favorable. Silver Chaff has also done well.

Ohio.—The reports are very numerous, and place a high estimate on Silver Chaff. Of the older varieties Fultz is preferred.

Oregon.—The Mold Wheats, particularly Mold's White Winter, have yielded remarkably well. These reports, coming from eleven counties, show a yield varying from 24 to 80 bushels per acre. In quality the grain is unsurpassed. All agree that these wheats are of great value to Oregon.

Pennsylvania.—Four reporters from different counties have done well with the Silver Chaff. The variety most commonly cultivated is the Fultz.

Utah.—Mold's White and Red Winter Wheats have done well in nearly all cases reported, and are likely to prove very valuable. Yield from 30 to 40 bushels per acre.

Virginia.—A great many reports have been received without indicating any very remarkable results. The Silver Chaff, Yellow Missouri, and Victor have done very well in some cases, but the general preference seems to remain with the Fultz and Tappahannock.

Washington.—As in California and Oregon, the Mold Wheats have given very heavy yields of excellent grain. They are described as "The finest wheat I ever saw." "The finest wheat I have seen in Washington Territory." "Yelds fully one-third more than the wheat I have sown hitherto." "Full, plump grain, 5½ feet high, heads 5 inches long." The quality of the grain is said to be "good," "very good," "excellent," "fine," "A 1," "tip-top," &c.

While the Mold Wheats have shown a remarkable adaptation to the grain-growing regions of the Pacific slope, they have almost without exception failed east of the Rocky Mountains. The reports of 1880 on these wheats are awaited with great interest.

West Virginia.—Reports from sixteen counties on several of the varieties distributed from this department show that nothing has been found that will supersede the Fultz and Clawson.

Wisconsin.—As a winter wheat Fultz takes the lead. Reports on Improved Fife (spring wheat) are uniformly favorable.

Reports on wheat have been received from nearly all States and Territories, and from most of them in very large numbers. From a careful reading of all, the following conclusions are reached:

1st. A large portion of the wheat sent out, probably one-half, falls into the hands of persons who do not comprehend the aims of the department in making the distribution, and are incompetent, through ignorance or shiftlessness, or both, to conduct experiments and make reports of even the slightest value to the department. This estimate does not take account of the large number of those who make no reports. It is noticeable that the reports and experiments of the regular correspondents of the department are, as a rule, much more valuable than the average. An investigation of the records would probably make this very apparent. A distribution confined to the regular correspondents, with a few exceptions in favor of farmers whose intelligence and means enable them to appreciate and forward the aims of the department, would bring results of far greater value than a miscellaneous distribution.

2d. The great want of the South is a *rust-proof* wheat. Varieties that are generally cultivated in the Northern, Middle, and Western States, because of their productiveness, and the quality of the grain are generally unreliable in the South. It is almost certain that wheat-growing cannot be made to pay in the cotton States.

3d. The prairies need a winter wheat that will not winter-kill.

4th. The most notable success has been on the Pacific slope, with the Mold Wheats. Next come the Silver Chaff in several States, and the Improved Fife in Minnesota, Wisconsin, and generally where winter wheat fails

OATS.

Illinois.—Whitesides County: From 4 quarts Board of Trade sown on 8 rods of land 5 bushels were harvested. "Very fine."

Indiana.—Bartholomew, Delaware, Marion, and Posey Counties report favorably on Board of Trade oats. Yield from 35 to 62 bushels per acre. "Much better than other oats." "Free of rust; stand up well; ripen ten days earlier than other oats."

Iowa.—Cherokee, Smith, and Washington Counties report heavy yields of Board of Trade oats. "Common oats yield about 20 bushels per acre." "Straw coarse and very strong. Recommend these oats beyond all others."

Kentucky.—Butler, Clinton, and Todd Counties give good reports on Board of Trade oats. Yield 40 bushels per acre. Quality good.

Michigan.—Genesee and Huron Counties: Board of Trade—"Excellent." "Full 15 per cent. better than Norway on same soil."

Minnesota.—Reports from several counties on Board of Trade. All very favorable.

Missouri.—Board of Trade from 46 to 53 bushels per acre. "Take less time to mature and yield more than any other, and better in every respect." "Stalk stiff, not liable to lodge."

New Hampshire.—Board of Trade—Sullivan County—6 bushels from 4 quarts sown. Weighed 37 pounds to the bushel; grew taller than native oats, and were ten days earlier.

New Jersey.—Mercer County: Board of Trade—"Growth vigorous. Weight 36 pounds per bushel. An acquisition."

New York.—Reports from Allegany, Cayuga, Chautauqua, Otsego, and Wayne Counties on Board of Trade oats all favorable. Weight 38 to 40 pounds per bushel. "Free from rust and not damaged by insects." "Straw bright-yellow, free from rust, while other varieties were both rusty and smutty."

Oregon.—Linn County: Board of Trade—"Large, heavy grain, weighing 42 pounds to the bushel."

Pennsylvania.—All reports on Board of Trade favorable. Lackawana County: "Straw stiff and heads well filled. Yield above the average. Think this a fine variety."

Utah.—Summit County: Red Rust Proof—"I consider them by far the best oats we have had in this part of the country."

Washington.—Snohomish County: Red Rust Proof—"Straw short and stiff, with large heads. Weight 40 pounds per bushel."

Idaho.—Ada County: Board of Trade—"125 bushels per acre. Grew 4½ feet high. Some heads maturing 194 perfect grains."

Indian Territory.—Board of Trade—"Fine growth. Very prolific. Suitable for this section."

G. Damkoehler, Clarence, Shelby County, Missouri, writes, April 5, 1880:

I had 6 acres winter wheat, 6 acres spring wheat, and 18 or 20 acres of common oats destroyed by chinch-bugs. They did not touch my Chinese Hulless oats. This may be owing to the oily coating of the latter. They will be of great value on this account if they can be acclimatized.

William Trenholm, Summerville, Charleston County, South Carolina:

In our section of country we are obliged to prepare in advance against *rust* by sowing cow pease fertilized with a mixture of German potash salt (*Kainit*) our phosphate rock and marl. I apply about 400 pounds per acre. The pease are sown broadcast in June and allowed to grow until the first frost of the winter turns the leaves. They are then plowed in and oats or wheat broadcasted over the land, about 2½ to 3 bushels per acre. Oats planted in this way are seldom affected by rust, but have been this year more than usual. The only oat, I think, that we can raise in this State with any chance of success is the Red Rust Proof, and even this has rusted in some parts of the State.

BARLEY.

Dakota.—Bon Homme County: Nepaul or Beardless—"The best barley I ever saw."

Minnesota.—Meeker County: [illegible]—"Excellent. Excited the admiration of every one." Freeborn and Otter Tail Counties report the Nepaul or Beardless barley badly blighted.

Nebraska.—Nepaul or Beardless: "The best barley raised. Hardy, heavy, and stiff straw and rich berry."

New Hampshire.—Merrimack County: "Promises to excel anything known in this county in quality and quantity."

Washington.—Snohomish County: Nepaul or Beardless—"Weighs 50 pounds to the bushel. The finest variety of barley I ever saw."

Wisconsin.—Sheboygan County: Nepaul or Beardless—"Blighted badly."

BUCKWHEAT—SILVER HULL.

Mr. Thomas W. Beatty, Conwayboro', S. C., writes, March 11, 1880:

Last summer you were kind enough to send me 4 quarts of buckwheat to plant as an experiment. At my request, Capt. G. Gilbert (of Bucksville) planted 3 quarts of this seed, on what we call second low lands, that is, neither high nor low lands. The ground was plowed and well pulverized with the harrow. The seeds were sown as follows: 1 quart on 20th of July, 1 quart on 1st of August, and 1 quart on 10th of August. While the grain was in a ripening stage a storm beat and tangled it very much, so that Captain Gilbert thinks he, in this way, lost from 2 to 3 bushels. The 3 quarts yielded 7 bushels of full, heavy buckwheat. The quantity of land planted was one-eighth of an acre. The yield was at the rate of 56 bushels per acre, and, but for the storm, would have been at the rate of 72 bushels per acre.

There is no reason why the best of buckwheat should not be grown abundantly in these Southern States, as the ground may be prepared and the seed sown after the other usual crops are laid by.

Captain Gilbert thinks the seed planted on the 20th of July did better than that planted on the 10th of August. So we conclude the proper time for planting buckwheat (as far south as this) is from the 20th of July to the 1st of August. The grain was gathered the first week in October.

UPLAND RICE.

Samuel A. Cook, Milledgeville, Ga., writes:

The cultivation of upland rice will be a feature of Southern farming ere many years, for it has already proven very profitable to many. June planting is becoming common, and any valuable crop that will permit of such late planting must be an acquisition. Its straw makes the finest of forage.

J. L. Caldwell, Marlin, Falls County, Texas, writes:

With proper management and a good season a fair crop could be made, but it could hardly be made profitable in this section and with our irregular seasons as a market crop. Farmers might do well to raise it for home use. Rice can never compete with cotton in Texas.

POTATO.

Alabama.—Reports from all sections of the State put a high estimate on the Beauty of Hebron. In earliness, yield, and quality it is unsurpassed. Potatoes are, as a rule, cultivated only for family use, and the seed is generally obtained from the North. It is thought that when a supply of the Beauty of Hebron can be secured, it will supplant the Early Rose, which is now the leading variety. Potatoes requiring a long season to mature are not reliable.

Arkansas.—Reports do not differ materially from those received from Alabama. In all of the Southern States great difficulty is experienced in keeping home-grown seed for planting. The only practicable method reported is to plant the ripened tubers of the first crop, and raise a second crop to be used for planting.

Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas, and Virginia all give reports similar to the above.

Illinois.—A great many reports are nearly unanimous in favor of the Beauty of Hebron. "Ripened 12 days before the Early Rose. Quite an acquisition." "Matured in 13 weeks." "Quality unsurpassed." "Fine large tubers; much better that Early Rose." "Undoubtedly superior to anything I ever saw in this country." "Valuable acquisition; two weeks earlier than Early Rose." "One week earlier than Early Rose; good keeper and very prolific; a valuable addition to our potato list." "I consider them too precious to eat, so I cannot give the quality." "Good the entire year, while the Early Rose is unfit for table in winter and early spring."

These extracts from reports received from Illinois are similar to hundreds of others on record from Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, Ohio, Oregon, Pennsylvania, Rhode Island, Tennessee, Vermont, Washington, and Wisconsin. The testimony of a great number of farmers in all parts of the country is uniform concerning the merits of the Beauty of Hebron, and leaves no room for doubt that it will supersede the Early Rose as the latter took the place of the Early Goodrich and other early varieties commonly cultivated fifteen or twenty years ago.

Good reports have been received from some of the late varieties sent from the department, but their success has been small in comparison with the Beauty of Hebron. This is probably owing less to any defects in the varieties distributed than to the fact that the list of first-rate late varieties is already adequate to the wants of all sections.

Mr. Hillary Ryan, Caldwell, Burleson County, Texas, says:

The Beauty of Hebron, which you sent me two years ago, outyields any other potato that I have seen in our country. I think it will prove very valuable. We can plant

no potato in this climate that is not early, and the earlier the better. Four years ago I planted Early Rose and Early Goodrich on the 1st of April, and in six weeks we had potatoes from them large enough for the table. Peach Blows do not make anything here but vines. I have never known them to produce a single potato. They shoot out as though they would make tubers, but the sprout comes up through the ground and makes a large vine.

Potatoes have not been raised here much for market, but I hope that our country will soon ship large quantities. We raise larger potatoes here than any I have seen imported, and they are ready for market by the middle of May.

Experiment of George R. Russell, Loudoun County, Virginia.

	Yield in pounds.
1 row, without manure	96½
1 row, ashes in bottom of hill	99
1 row, ashes on top of hill after covering	112½
1 row, plaster in bottom of hill	120½
1 row, plaster on top of hill after covering	109½
1 row, Peruvian guano in bottom of hill	102½
1 row, Peruvian guano on top of hill after covering	115½
1 row, "dissolved bone" in bottom of hill	139
1 row, "dissolved bone" on top of hill after covering	118
1 row, hen manure in bottom of hill	115
1 row, hen manure on top of hill after covering	93
1 row, Powell's Fertilizer in bottom of hill	117
1 row, Powell's Fertilizer on top of hill after covering	96

The rows were all of equal length. The quantity of manure used on each row was one half gallon. The bone cost $40 per ton, guano $65 per ton, Powell's Fertilizer $16 per ton.

Powell's Fertilizer was composed of 300 pounds dissolved bone, 50 pounds magnesia, 30 pounds ammonia, 50 pounds potash. Cost, $12; mixing, $1; total, $13.

The months of July and August were very dry. Scarcely any rain.

ARTICHOKE.

J. M. Peffer, Little Traverse, Mich., writes, April 7, 1880:

I have just dug the Red Brazilian artichoke. They are much larger than the tubers sent from the department, and yield enormously. From nine stalks I got more than a bushel. This indicates a yield of 800 to 1,000 bushels per acre.

Martin J. Barger, Bismarck, Vermillion County, Illinois, writes, May 30, 1880:

My success with the Red Brazilian artichokes sent to me from your department was very satisfactory. I planted one row three rods long, hills three feet apart, one eye to a hill. Soil, light clay, well manured, and would produce 75 bushels corn to the acre. Dug my artichokes about the middle of April and measured 6 bushels, making a yield of 1,600 bushels to the acre. A great many were left in the ground, as the sprouts clearly indicate. I think they could be made to yield 2,000 bushels to the acre. I find that, eaten raw, they are equal, in their way, to turnips, and served up like new potatoes, they come in as such any time from November to the middle of May. Horses, cows, pigs, and sheep eat them with a relish.

B. M. Long, Peoria, Union County, Ohio, writes, April 16, 1880:

From two quarts Brazilian artichokes planted last spring I plowed up yesterday 6 bushels. Horses, cattle, and hogs all relish them.

John P. McClearn, Bridgeton, Pa., writes, March 5, 1880:

Thirteen hills Red Brazilian artichokes produced one bushel, at the rate of 500 bushels per acre. I think that in a good season, on moderately good ground, I could raise 800 or 1,000 bushels per acre.

L. Claude Lachecoth, Waverly Mills, Georgetown County, South Carolina, writes, February 16, 1880:

The Red Brazilian artichokes were planted February 15 on rich, sandy land, well manured. Hills 3 feet each way. They grew 7 feet high and covered the whole space between rows. Dug them November 20. Yield 6 quarts to the hill, about 1,000 bushels per acre.

Alabama.—Chambers County: Red Brazilian, 1,600 bushels per acre. "As a crop for hog-feed they cannot be excelled."

Arkansas.—Columbia and Prairie Counties: Red Brazilian, "Yield remarkable." "Attracting a great deal of attention here."

California.—Calaveras, Contra Costa, and San Mateo Counties give good reports on the Red Brazilian. Promise most wonderful results in the way of feed. Think they would yield 4,000 bushels per acre with good management.

Florida.—Sumter County: Red Brazilian, 1,200 bushels per acre. "Undoubtedly the best food for pork that can be raised in this country. Too sandy for corn."

Indiana.—Decatur County: Red Brazilian, "They will supply a long-felt want of the American husbandman, in keeping hogs free from diseases, which have made their appearance since the destruction of our forests. Soil and culture same as for Irish potatoes."

Indian Territory.—"The Red Brazilian artichoke is a wonder and a blessing to farmers. From 13 hills I raised 2 bushels, from soil nearly hot enough to roast an egg."

Kentucky.—Livingston County: Red Brazilian, "7½ bushels from 2 quarts. Soil and culture same as for Irish potatoes."

Michigan.—Little Prairie, Ronde County: Red Brazilian, "1,100 bushels per acre." Barry County: "5½ bushels from 1 quart planted."

Missouri.—Audrain County: Red Brazilian, "9 bushels from 1 quart, 1,000 bushels per acre. Beats the world for yield."

Nebraska.—Sarpy County: Red Brazilian, "600 bushels per acre. Will be a valuable substitute for corn in feeding hogs."

Texas.—Fannin County: Red Brazilian, "The best I ever saw in any climate."

West Virginia.—Gilmer, Harrison, and Randolph Counties: Red Brazilian, average yield at the rate of 650 bushels per acre. "Season very dry. The crop would have been doubled with rain."

Wisconsin.—Clark County: Red Brazilian, "Hogs prefer them to corn."

The culture of artichokes for stock feeding is attracting much attention. They flourish in a wide range of soils and climates, and may be expected to come into general use for stock feeding, particularly in sections where corn does not flourish. An important element of their value for swine is in their availability, where the ground does not remain frozen, during the entire winter and spring, without any cost for harvesting.

FORAGE PLANTS.

John W. Robson, Cheever, Dickinson County, Kansas, writes:

I have been experimenting largely in forage plants the past two years. Among the millets, the Common Hungarian, German or Golden, and French give large returns in hay and for soiling. Lucerne or Alfalfa does well, giving from two to three crops during the season. Red clover is a success. Among the grasses, Orchard grass (*Dactylis glomerata*) suits this latitude better than any other grass I have tested, affording good grazing at all seasons of the year, and withstanding drought well. On the uplands it is always green and very hardy, more so than our native grasses. Timothy (*Phleum pratense*) gives a good crop of hay in June, but we cannot depend upon it for grazing purposes if the summer is dry. This season the Timothy pastures were brown from July till October; now they are green. Blue grass (*Poa pratensis*) is not a success in this part of Kansas. In dry seasons it does not grow higher than Buffalo grass, and soon becomes brown. In damp situations, on river or creek bottoms, it thrives well, but on the uplands it does not sustain its eastern reputation. Red Top (*Agrostis vulgaris*) is valuable when grown in dry runs or swales.

The farmers of this county will be compelled to turn their attention to the cultivation of artificial pastures. The area of prairie pasturage is rapidly diminishing, hence the necessity for cultivating the *tame grasses.*

Pearl millet.

A. P. Hallock, Le Roy, Medina County, Ohio, writes:

The Pearl millet did not prove satisfactory with me. This was partially due, however, to the extremely unfavorable season, as the seed did not germinate for nearly or quite a month after planting, and then the plants made so slow a growth that only one crop was harvested, and that late in September. No shoots were sent out after cutting. The soil was a sandy loam with clay subsoil. Method of planting, in drills 3½ feet apart and plants 1 foot apart in the row. Cultivation same as corn in same field received. Land not very rich, but kept entirely free from weeds. I raised 2 acres of corn fodder in same field with better results as to yield, and stock eat it much more readily than the millet. It seems to be somewhat coarse and woody, which may be due to its unusually slow growth and maturing. I am inclined to think, however, that corn fodder, of the sweet variety, if properly grown and cultivated, is superior as a forage plant for our soil and climate.

W. F. Morrows, Somerset, Hillsdale County, Michigan, writes substantially as above.

John Whitely, Shirley Village, Mass., writes, March 6, 1880:

The seed was sown May 22 in drills 20 inches apart, and thinned out to 12 inches between the plants soon after they started. The plants grew rapidly at first, but the cold weather of June checked their growth. About the 1st of July they took a start and grew vigorously till September 21, when we had a smart frost.

The seed was sown at the rate of 4 pounds to the acre; one pound is enough. Commenced to thin again and feed about the 1st of August, when the product would have been about 35 tons to the acre in the green state. It was in the best condition to feed at this stage, though the yield would have been 46 tons per acre at a later period, and much more if the weather had been favorable. The ground is a sandy loam, and was highly manured with superphosphate, muriate of potash, and pulverized cow-hoofs.

Nothing is raised in these parts that cattle will eat with greater relish while it is green and tender. Our experiment was not sufficiently thorough, perhaps, to enable us to form a very accurate conclusion as to its nutritive qualities. If to be cut for hay, it is best when two-thirds grown.

O. G. Waller, Greenwood, Abbeville County, South Carolina, writes: "The Pearl millet is a success. The very thing we need."

Samuel Cross, Landisville, Atlantic County, New Jersey, says:

The millet seed was sown about the 15th of May in rows 3 feet apart, and the plants 2 feet in the row. The plants did not make much headway until the second hoeing. After that they grew very rapidly. When about 3 feet high I commenced feeding to horses and cows. Both seemed to relish it better than corn-fodder. The second growth was cut when about 6 feet high. After drying a short time it was tied in small bundles and shocked. I am now (February 2) feeding it to horses and cows, after running it through a fodder-cutter. On the whole I think it is a success, and will continue to cultivate it. It has been said that the seed would not mature in this latitude, but a part of a row left rewarded me with fully ripened seed. I would further say that the land was only moderately fertilized, my intention being to treat the millet in my first experiment about as I do corn, and to compare notes.

A. G. Hill, Halfrock, Mercer County, Missouri:

It proves to be an excellent fodder for all kinds of stock. It is a good pasture for *bees* when in bloom. They can gather bread from it faster than from any other plant. I cultivated once with the hoe. Seed ripened October 15. Heads 12 to 16 inches long.

H. Caswell, Igo, Shasta County, California:

Sowed May 29, in drills 18 inches apart, in clay soil. The ground was new and not manured. I cut, on September 15, at the rate of 31 tons, 972 pounds of green fodder per acre. I think it was cut too late, as it did not sprout again. It would be a great feed for *bees*, as they worked on it in great numbers. Horses and cattle seem very fond of it. It will not mature here without irrigation, which will be a drawback to its coming into general use.

Alfalfa.

Mr. T. F. Meece, Livingston, Polk County, Texas, writes, May 4, 1880:

I sowed alfalfa in August last, or September, with turnips and black winter oats, all in drills. The ground was previously well prepared and highly manured. Pro-

cured a fine stand of oats, turnips, and clover, all of which grew finely until the 24th of December, when we had a "Norther" of such severity as to kill the oats, and injure the turnips and other vegetation. The clover was not checked, is now in full bloom, and presents a sightly appearance. I am well pleased with it.

A sample of alfalfa in bloom, showing a very luxuriant growth, accompanied this letter.

H. Ryan, Caldwell, Burleson County, Texas, writes:

California clover is giving good satisfaction in our county for winter pasture. We have nothing, perhaps, as good. The Rescue grass was doing well in our county, but the grasshoppers three or four years ago entirely destroyed it.

Franklin Doswell, Esq., Jacksonport, Ark., writes, April 30, 1880:

In March, 1878, I received from the Agricultural Department at Washington a small package of alfalfa seed. I sowed it about the 1st of April of that year in alluvial soil with a clay subsoil, with a fertility of 40 bushels of corn to the acre. The soil was well prepared by deep plowing and harrowing. During the first year the natural grasses apparently choked out the alfalfa, it becoming of a pale-green color. The winter of 1878-'79 was quite severe for this latitude, and the alfalfa was killed down to the ground. As early as February, 1879, it made its appearance above the ground, long before any of the natural grasses or weeds. In March, 1879, there was a severe spell of weather, which did not affect the alfalfa otherwise than to check its growth. It put up ahead of the natural growth of the soil, and choked out the latter. By the middle of May the alfalfa was ready for mowing, but, desiring to save the seed, it was not mowed. It was mowed, however, twice during the summer without injury.

The winter of 1879-'80 was very mild for this climate. The alfalfa remained green and fresh during the winter, and continued to grow during warm spells of weather. By the 1st of April, 1880, it was ready for mowing, and was thereafter mowed, from day to day, for soiling milch cows. At this date, April 30, I am mowing over it the second time. It comes early, the growth is rapid, and the yield abundant. Horses, cows, and hogs eat it with avidity. It is not more difficult to cure as hay than red clover, and is equally as good. It is easily eradicated if desired.

The chief difficulty to be apprehended in cultivating this crop is to secure a stand during the first summer. It is probable that sowing early in the fall would obviate that.

Egyptian rice-corn.

J. H. Krancher, Millheim, Austin County, Texas, writes:

The production of forage plants suited to the climate of the extreme Southern States is of vital importance. The great summer heat, its long duration, and the always recurring droughts are fatal to many plants on which farmers of more northern latitudes rely for forage. Your department cannot better aid the southern farmer than by distributing suitable forage-plant seeds. With the exception of Bermuda grass, which can only be considered a summer pasture grass, and the Johnson grass, which is only suitable as a soiling plant on large stock farms, there is scarcely a perennial plant suitable for forage that will withstand our summer heat. Hence, our main reliance is on annuals, particularly the sorghum family.

With a view to meeting the want above referred to, the department has made a liberal distribution of seed of the *rice* or *Egyptian corn*, and other varieties of sorghum. Alfalfa has also been introduced in many sections where it has not heretofore been grown, and reports thus far indicate its success. (See letter from Polk County, Texas.)

W. Bomer, of Helotes, Bexar County, Texas, reports as follows:

Planted on the 27th of March in drills 3 feet wide, dropping seed 15 inches apart, two seeds in a hill. Intentionally this crop received no better cultivation than the crop of Indian corn, which was two horse hoeings and one hand hoeing, no fertilizer used nor required. The crop was cut on the 10th of July, producing 10 bushels; area planted was one-fifth of an acre. This corn produces more suckers than Indian corn. Experimented on two rows by depriving them of the suckers; no perceptible difference in the size or amount of the grain in the plants that were suckered from those that were not; but the suckers each produced a head or ear of about a quarter size of that produced by the main stalk.

This cereal is very suitable to Western Texas; it has one serious drawback in the weevil. Thirty days after thrashing the whole grain was full of weevil; the birds also

commit depredations on the ripening grain, which might not be serious if planted in larger areas. Had it ground: the flour is inferior to wheat, but superior to Indian corn. The Indian corn in the same field and with the same cultivation produced from 20 to 25 bushels (shelled) to the acre. This was not a full crop. It should have been nearly double the quantity. The cause of this was the soil being so dry from the nine months' drought of last year, the light rains of this spring not saturating the ground sufficiently, not penetrating more than 12 inches; beneath that it was dry. The Egyptian corn is preferable to Indian corn.

F. A. Rew, of Urbana, Dallas County, Missouri, says:

Last season I planted the China corn, or Brown Doura, in drills, and cultivated. The yield was 12½ per cent. more than Indian corn treated in the same way. Stock ate it ravenously; and in the milk and butter of cows fed largely upon it we failed to notice the bitter taste always perceived when they are fed much on Indian-corn fodder. I could not see that the quantity of milk was in any way affected. I could not see that work horses fed on it showed any change, though they seemed to eat a great deal of it. This season I sowed the seed broadcast like oats. The yield is by weight per acre 60 per cent. more than millet growing by its side. I am not informed as to their relative value per ton as fodder. But the great amount of labor required to harvest, cure, and stack it, will prevent its coming immediately into general favor. Forage crops are of the first importance to us in this section, but good help is so scarce that the amount of work required to handle a crop is an important item. In this respect, a well-set meadow is far ahead of China corn. At the East the question seems to be, "How much can be raised from one acre?" Here it is, "How much can one man raise?" Here land is cheap and help scarce.

G. W. Marnock, of Helotes, Bexar County, Texas, says:

I am glad to state that the Dhura or Egyptian corn has been a success, notwithstanding any amount of dry weather, and giving a return of from 50 to 60 bushels per acre. It was planted the 25th day of April, in drills 4 feet apart, and harvested on the 28th of July. At the present time (August 18), it is about to return a second crop. Young shoots have sprung from the roots, often numbering ten to fifteen, and each promises to bear ears of good size, although somewhat smaller than those first produced. I have had some of the seed ground, and find that it makes bread almost if not quite equal to corn (maize). All domestic animals eat it; horses prefer it to the Indian corn. Without doubt this crop will be of great value to arid regions. It withstands any amount of drought, giving a yield double that of Indian corn.

There is a vast region in our country similarly arid to the western part of our State, in which wheat in character like that of the north of Africa is much to be desired, or barley from Arabia. It will have to be sought for in some arid region, Asia or Africa; but a successful result will be attained, I have no doubt, and thus give value to numberless acres to which no cereal is now adapted, the Egyptian corn alone excepted. It is not particular as to soil. That which was planted on sandy soil did as well as that on our rich bottom-land.

COTTON.

Thomas W. Beatty, Conwayboro', S. C., writes, March 12, 1880:

I planted 3½ quarts of Baggarly's Large Boll Prolific Cotton April 4, 1879, and mixed seed of the Dixon Cluster, Gaddy's Improved, &c. The soil was sandy loam, with a sandy foundation (generally considered unfit for cotton, a clay foundation being more desirable). The ground was plowed in February. The last of March, after being well pulverized with the harrow, it was laid off for rows 4 feet apart, by plowing furrows from 6 to 7 inches deep. In these furrows I strewed coarse manure and covered with two furrows, making a considerable ridge. These ridges were flattened with the harrow until they were about two inches above the general level. I planted, putting 4 seeds to the hill and the hills 18 inches apart. The different varieties received the same treatment in all respects. The Dixon bloomed and showed open bolls two or three days earlier than the Baggarly. From the second picking 72 bolls of the Dixon and 49 bolls of the Baggarly each weighed 1 pound.

In September my cotton took the rust. The Baggarly was free from it more than a week longer than the other kinds, and after they were entirely destroyed it remained green for about 20 days. I think it bloomed and bolled quite as freely as the other varieties.

I found that the Baggarly seed from 1 ounce of seed cotton weighed 480 grains; the Dixon 470 grains. So I conclude that the Baggarly will yield about 1 pound of lint to the 100 pounds of seed cotton, less than the Dixon. The seed of the Baggarly is

nearly half as large again as that of the Dixon, and it only surprises me that the lint yields so well.

The Baggarly has the advantage over the other in picking, as it takes as much or more time to pick a small boll as a large one, and 100 bolls of the Baggarly yield about one-third more seed cotton than the same number of the Dixon.

H. F. Lipperd, Ashland, Benton County, Mississippi, writes:

I planted the Baggarly cotton seed May 8 on rich low land. The growth was fine, manifesting its original form of bottom branches; bolls very large and blunt; opened well. From 70 pounds of seed cotton I had 22 pounds of lint. I have saved the seed and intend testing it thoroughly this year.

John W. Pitts, Wilsonville, Shelby County, Alabama, writes April 20, 1880:

In the spring of 1876 I received from your department a package of cotton seed known as the McLenden Prolific. This variety seems peculiarly adapted to this climate. It proved so far superior to any other in this section that I have no hesitancy in saying its introduction has been worth to this county alone thousands of dollars.

F. R. W. Bock, of Macon, Miss., says of Baggarly cotton:

The best ever known here; largest boll; heavy lint; as prolific as the best; an acquisition.

Robt. N. Huger, Triangle, Lincoln County, North Carolina, writes:

Baggarly's Large Pod Prolific, planted April 25, in hills 3 by 2 feet on nine-tenths of an acre. Yield 1,460 pounds of *white* and 26¼ pounds of *stained* cotton in seed. Staple long, strong, and very white, but coarse. Market 2¼ cents better than other varieties. Yield per acre 28 per cent. better than common kinds. Growth of plant vigorous and regular. In July the condition of the plant was 50 per cent. higher than the old varieties, but it lost much of this in the fall and was at least a week late in October.

Soil, light sandy, with yellow clay bottom. Fertilizers used, ammoniated bone superphosphate, at the rate of 300 pounds per acre.

I. I. Mitelle, Secretary Oak Grove Agricultural Society, The Grove, Coryell County, Texas, writes, January 1, 1880:

The McLendon Prolific cotton is a splendid variety. Our farmers are well pleased with its growth, staple, and yield the past season. Notwithstanding the drought it yielded 1,200 pounds of cotton in seed per acre. It is undoubtedly the best variety we have, taking all things into consideration.

O. E. Taylor, Hempstead, Waller County, Texas, says of the McLendon Prolific, "It is the finest cotton I ever had."

Mr. J. L. Moultrie, Union Springs, Bullock County, Alabama, says:

On soft sandy land deep plowing makes the soil too loose and spongy for cotton. On common stiff land deep breaking causes a greater retention of moisture and prevents throwing off the fruit in dry weather. Where land is very rich and cotton runs to weed, it is better not to change the bed, and never to break any depth, but let the soil become quite compact. I have seen land that when deeply plowed would grow cotton 7 to 8 feet high and with a very uncertain yield, but by allowing it to become compact the cotton grew only 4 to 5 feet, and gave a certain crop of 1,500 pounds per acre. Cotton is always injured if plowed deep in July. Stable manure is an *effectual preventive* of rust.

I wet and rolled some seed in strong ashes and left 3 or 4 bushels in a basket. At the end of 48 hours they had sprouts 2 inches long. Rolling seed in a fertilizer does no good, because the hull comes up on top of the plant and thus brings up the fertilizer.

Cotton-seed planters effect a great saving of seed, but they throw the seeds so close together that it is difficult to separate the plants with a hoe when reducing the stand to single stalks. The young plant is very tender, and if skinned by the hoe will be sure to die. We need a planter that will throw the seeds one inch apart.

CABBAGE—CAROLINA BUNCOMBE.

Arkansas.—Garland and Prairie Counties: "Excellent for size and flavor." "The best variety for this climate."

California.—Humboldt, Mendocino, and Santa Cruz Counties: "Many of the heads weigh from 10 to 25 pounds each." "Nice flavor; heads very hard."

Florida.—Wilkinson County: "Never had a better or more reliable variety of cabbage than this."

Louisiana.—Bienville and Caldwell Counties: "The finest I ever saw." "I raised heads that would fill a half bushel."

Michigan.—Gratiot County: "Sweet and tender, No. 1. Heads burst open, the only difficulty."

Minnesota.—Mower County: "Heads one and a half times larger than other varieties under the same conditions."

Mississippi.—Attala, Winston, and Yalabusha Counties: "Superior to any cabbage I ever saw grown in Mississippi." "Very large and fine." "Would rather pay two prices for this seed than be without it."

Nebraska.—Hall County: "Well headed, large, solid, crisp, and sweet. Excellent."

South Carolina.—Granville County: "Hard heads; very fine. The best cabbage I ever raised."

North Carolinia.—Adams County: "Every plant produced a fine large head."

Texas.—Bell and El Paso Counties: "Promises well. The best I have tried."

This variety originated in Buncombe County, North Carolina. Many reports received from the Southern States indicate that it is the best late-keeping or winter variety known for a warm climate. It meets a well-defined want in our Southern States, and is therefore of great value.

EXPERIMENTS WITH CORN.

We are indebted to Mr. A. W. Ross, of Northfield, Mass., for the following statement of the results of five years' successive experiments on a field of 30 acres planted with corn:

In different sections of the field the soil is light sand, sandy loam, clay loam, and a wet, heavy, cold, black soil, thus giving quite a variety to work on. My method of preparation was, the first year, to plow in the fall and cultivate in the spring before planting. The second year I plowed late in the fall and cultivated before planting. The third year I plowed in the spring. The fourth year I plowed in the fall; and the fifth and sixth years in the spring, in all cases preparing the ground well before planting. Manure from the barn is always spread broadcast; if old stubble land, and there is time, it is plowed in; if not, it is spread after plowing and cultivated in. Always spread the manure quite liberally as far as it goes, and generally use wood ashes for the remainder of the piece. I never have used much of fertilizers which are manufactured for sale, excepting in the drill, with the seed when planting, from 100 to 200 pounds per acre, as might happen. The ashes and other fertilizers used outside of the drill are spread broadcast and cultivated in the same as barn manure, but never plowed under. The manures from the barn are used on the wet, heavy soils; the ashes on the lighter soils. The manufactured fertilizers do best on the moist land, unless there is plenty of rain. After the land is prepared it is planted with the Ross horse planter, which moves all rubbish out of the way, prepares the seed-bed, makes the furrow, drops the seed, fertilizes, covers, and rolls the land over the seed. It also marks for the next row. If the land is weedy and requires early cultivation I use the Ross hand wheel hoe, by which a man can hoe from four to six acres a day; if not, when the corn is large enough I use the Ross horse cultivator first and afterward the hilling machines. The work is done better with these machines than men can do it with hand hoes.

The above is my method of raising corn. It never fails. For fifteen years no drought has troubled my crops.

The first year I used no manure, and the yield was not over 30 bushels shelled corn per acre. Since that time there has been barn manure, ashes, and some superphosphate applied every year, and the result has been a yearly increase of the crop.

As we raise corn it does not cost over $1.25 per acre to plant and hoe it through the season. Do you ask how it was done? I pay my hired man $15 per month and board

him on the farm. He will plant and hoe, with a little assistance, the 30 acres, and do enough other work to nearly or quite pay for his board. We are thus able, on good farming land not worth over $75 per acre, to produce corn at a very small expense. In the New England States the fodder, if properly managed, will about pay the whole cost of raising the crop, and leave the corn for a net profit.

When corn is grown, cut up, bound and stooked in the field, it is then *raised* and ready for feed. Then commences another branch of the business; that is to say, *marketing*. We may waste the whole crop, or feed or dispose of it in such a way as to nearly or quite double its value. From my own experience for fifteen years past, I am satisfied that to husk, bin, shell, carry to mill, pay the miller for grinding, and return to the barn in meal, costs from 30 to 40 cents per bushel, according to wages, the distance from mills, &c. That being the fact, it is really worth but little at the present prices of 50 or 55 cents per bushel. I have for two years past used a husking machine in the barn, and done the shelling and grinding by horse-power, and yet I am of the opinion that there is more net profit in feeding corn and fodder in the bundle, and buying Western corn, than in husking and grinding our own corn in the Eastern States. We have for six years fed much of our corn in that way, and used the money it would have cost to harvest and get our own corn into meal, to buy surplus meal for our extra feed and manure heap, which has a great tendency to improve the farm.

VEGETABLE FIBERS IN THE COLLECTION OF THE DEPARTMENT OF AGRICULTURE.

LETTER OF SUBMITTAL.

NEW YORK CITY, *May* 22, 1880.

DEAR SIR: I herewith submit to you my fiber report, which has been prepared as nearly as possible in accordance with your instructions, as a contribution to the fiber literature of the times. The report is in two parts; the first portion, or report proper, being a descriptive catalogue of the vegetable fibers at present in the museum of the Department of Agriculture, many of which were collected by myself, through the national museum at the Philadelphia Exhibition of 1876; and the second portion, the results of an inquiry into the present status of fiber industries in this country, pursued during the past winter.

The design of the first part has been to bring together in most condensed form descriptions of the principal fibers known to commerce, or of value for textile purposes in our own and other lands, with sufficient technical matter for their determination, in order that their uses, mode of preparation, and commercial value, may be brought to public attention. Such a work it is thought will prove of great value to many interested in fiber industries, and especially to manufacturers, who are often at a loss to know the true value, or position, even, in the vegetable kingdom, of fibers submitted to them.

Many of the species herein enumerated are either indigenous to our soil, or can be grown in some portion of our vast domain; they should be better known to agriculturists as well as manufacturers, as a knowledge of such sources of wealth is the first step towards utilization.

I would also suggest that, by means of such a work, the usefulness of the museum of the department as an educational institution may be extended to those who are unable to personally examine and study its collections in this particular branch. That it may also serve as a stimulus to the forming of other similar collections, for public instruction in our colleges and natural history museums, I have no doubt.

The second portion of the report relates particularly to our flax and hemp industries, the subject having been treated only in its practical bearings as an element of national prosperity. Jute, as intimately connected with the fiber manufacturing interests of the country, has received due consideration, and a closing portion of the report is devoted particularly to the cultivation and preparation of other fibers which should receive attention in American agriculture. The report has been prepared particularly

with a view of impressing upon our farmers at this time the importance of fiber cultivation as an element of farm practice, in the hope that languishing industries may be revived, and new ones established. The present extent of American fiber industries is shown, the best practice in regard to cultivation and preparation of the fiber has been given, and the subject of manufacture and machinery briefly considered. The special encouragements and hinderances have been carefully and impartially presented, in the hope that those most interested may profit by the suggestions.

I take this opportunity of bringing to your notice the names of a number of gentlemen and firms, to whom I am under obligation for kindly assistance rendered, as well as for specimens of fibers which are herewith presented to the museum. My acknowledgements are specially due to Mr. Emile Lefranc, of Philadelphia, Prof. S. Waterhouse, of Saint Louis, Dr. Samuel C. Brown, of Newark, N. J., Mr. J. R. Proctor, Frankfort, Ky., Messrs. Tucker, Carter & Co., and Barbour Bros., of New York City, Messrs. R. B. Storer & Co., of Boston, and Joseph Chisholm, of Salem, Mass.

Specimens of fibers were received from Mr. Chisholm, Messrs. Storer & Co., who donated some fifty or more samples of foreign flax; Cable Flax Mills, New York, Mr. Lefranc, ramie; Mr. D. Hickox, Springfield, Ill., who sent samples of flax and abutilon paper; A. Stoner, Stony Point, La., and Charles Lauga, New Orleans, La., samples of bagasse, and paper made from it.

I have also to thank you for kindly assistance in supplying and sending out the circular to manufacturers, and for encouragement and co-operation in the work.

I have the honor to be, very respectfully, yours,

CHARLES R. DODGE.

Hon. WM. G. LE DUC,
Commissioner of Agriculture.

VEGETABLE FIBERS.

PART 1.

Very large and valuable additions of textile and other fibers have been made to the museum in the last two years, embracing not only a full series of the more valuable foreign fibers, but many that are rare and little known. As these are in many instances accompanied by interesting and reliable data, and as the fiber series is now quite complete, it seems fitting that the collection should be fully described for the benefit of the many who are unable to avail themselves of the benefits of the museum. To that end, at your request, I have prepared the following report on the vegetable fibers at present upon exhibition in the museum, with particular reference to those generally mentioned as *miscellaneous fibers*, many of which are comparatively little known in this country, even to our manufacturers.

Many of these form large industries in foreign lands, that are considerable sources of wealth, some of which might, perchance, be produced in our own country and add to its already vast resources. Others are known only to a very limited extent as commercial products, and are chiefly valued by the natives of the countries in which they are indigenous, who prepare and manufacture them rudely for personal wants; a few, perhaps, are almost entirely unknown, and their names, rarely, if ever, mentioned in lists of fiber plants. Although the report includes the principal known vegetable fibers and fibrous substances of which specimens could be obtained, a few, already well known in the United States—cotton, flax, ramie, jute, and hemp—have been given but a pass-

ing consideration, as their mode of growth and preparation, as well as the appearance of plants and fiber, are matters with which the majority of our readers are more or less familiar.

The aim has been to give, first, a list of plants producing these fibers, with the scientific and common English names by which they are designated, and the native names by which they are known in countries where they are indigenous; habitat of the plant, and geographical distribution; mode of cultivation, where cultivated, preparation and uses; appearance of the fiber, and comparisons of tenacity with other well-known fibers, hemp (*Cannabis sativa*) having generally been taken as the standard; general remarks as to production, &c., where such data have been thought of interest, or the fiber produced has any commercial importance.

As to classification, for convenience of reference, in a report of this nature—which is intended as a partial descriptive catalogue—the plants have been arranged by families. This enables the reader to note their relations to each other in the vegetable kingdom, and gives a botanical interest to the report in addition to its economic bearings. A few pages farther on an economic classification has been given, based upon the value of the fibers in relation to the uses for which they are adapted. This classification is recommended as a basis of museum arrangement, as the *economic* value of the various fibers in an industrial museum is a matter of far more interest to the general visitor than their *scientific* relations. This classification or arrangement has been partially followed in the museum of the department, and in its practical aspects is the only useful one that could be adopted.

The scientific name of the plant producing the fiber has been determined in nearly every instance—but two or three species only remaining unnamed—and it designates the species in the descriptive list. In this way only can confusion be avoided, for these names are known to all countries, while the common names are more numerous than the countries producing the plants, and differ in various sections of the same country. The commercial nomenclature has been very much confused, and to such a degree that several fibers may be known by the same name, while perhaps each fiber at the same time has half a dozen other names. A great source of confusion is the extended use (often indiscriminate) of the word *hemp*, which in some cases even is made synonymous with the word *fiber*, as "Jute hemp," several specimens having been received into the museum with this labeling. There is but one true *hemp*, and that is the product of *Cannabis sativa;* it is known however as "Russian" or "Petersburg hemp," "Europe hemp," "Himalayan hemp," "Deyra" or "Arracan hemp," "Kota Kangsa hemp," &c. Other fibers bearing this name are: "Sunn hemp," *Crotalaria juncea*, which is known in the markets as "Calcutta hemp"; "Madras hemp," "Conkanee hemp," "Bombay hemp," and "Brown hemp," while the true "Brown hemp" of Bombay is *Hibiscus cannabinus*, also called "Deckannee hemp." "Jubbulpore hemp" is the product of *Crotalaria tenuifolia*, and "Bowstring hemp," *Sanseviera Zeylanica*, also known as "African hemp," while *Calotropis gigantea* is also called "Bowstring hemp" in India. "Manila hemp" is the well-known fiber of *Musa textilis*, and "Rosella hemp" of *Hibiscus sabdariffa*—without synonyms. One of our indigenous plants, *Apocynum cannabinum*, produces "Indian hemp," while Indian hemp in the East Indies is *Crotalaria juncea*, named previously *Agave Sisalana*—a plant that might be grown in our own country—produces "Sisal hemp," which, to make still greater confusion, has been called "hemp grass" (also "Mexican grass" and "silk grass"), when it is not a grass in any sense of the word.

The name "grass" is also given to a number of fibers which cannot be classed with the *Gramineæ*. "Monkey" or "Para grass" is the fiber of a palm, *Attalea funifera*, and "Bear-grass" is a name given not only to two species of Yucca, but to *Dasylirion graminifolium*, widely distinct plants. Even "China grass" is a misnomer. "Pita" is the fiber of *Agave Americana*, and the name has also been applied to *Bromelia sylvestris*. In the same catagory *Agave Sisalana* produces "Henequen" fiber, and this name is also given to Yucca fiber in some of the European markets, doubtless from having been exported with the true Henequen. So the name "Tucum" the fiber of *Astrocaryum tucuma*, in Brazil, is also given to *Bactris setosa*, and the synonyms are "Tucum, Tecum, Ticum" and "Tucuma," variously applied to several plants.

When we come to native names the case is almost a hopeless one, jute having *sixty-four* different appellations, from "Pat" to "Bow moochkee koshta," in India alone. Then there is much confusion in regard to the spelling of names by different authors, in some cases their orthography being so varied as to make totally different names, and their similarity can only be traced by pronouncing them aloud without looking at the letters. (*Jectee* and *Chitee* are examples.) A very few of the *commonest* of these native names, however, have been given to make the list of more value in naming species, as frequently the writer has had but an obscure native name by which to identify the fiber and learn its history, and more than once, after fruitless endeavors, has stumbled upon the name in connection with a better known one, after which it was an easy matter to verify the names and establish the species.

It is impossible to give the habitat of some of the fiber-producing plants of our list, the native homes of well-known species often being the hardest to determine, as, by cultivation from remote ages, they have become denizens of the whole world, and, escaping from cultivation, are found side by side with truly native species, holding their places with them in the struggle for existence. The cotton plant and the cocoa palm are familiar examples. Much study has been given to the subject, much has been conjectured, and much written, but in the end, while we are willing to accept the statements, we lack the proof. Plants are introduced from one country to another in various ways. The cocoa palm is thought to have been disseminated to the four quarters of the globe by the waves and tides of the ocean, and other plants have likewise been carried by the seas to remote lands, and there sprung up, fruited, and established themselves.

A recent German writer, in speaking of the American plantain (see fiber list), which grows in such luxuriance in the tropics, and is *seedless*, suggests that the importation took place while the polar regions enjoyed a tropical climate, and was brought by emigrating Asiatics by way of Kamtchatka and Alaska. With species that have become introduced in more modern times, it is easy to trace them to their native homes. The study of the geographical distribution of plants is an interesting one, and one, too, that has a practical bearing upon the industries of a country, and especially in relation to agriculture, and whether we wish to bring a new fiber plant from a remote country, or a new wheat from a distant State, there is but one question to be asked: "Will it grow here?"

Many of the fibers in this list are derived from plants that are found growing without cultivation, and the fiber only used to a very limited extent by the natives, and prepared in the rudest manner. Other plants are cultivated, and the fiber extracted by uniform methods of preparation, and in all such cases brief data have been given commensurate with the importance of the fiber. To those species which produce

fibrous material of commercial importance, as full a history of the modes of cultivation, preparation, &c., has been given as is compatible with the limited space offered in a report of this nature.

Fiber has been used in all ages and in all countries from the remotest periods, either as clothing or cordage. Even our first parents are recorded as sewing fig-leaves together for clothing. From the primitive use of fiber and fibrous material, limited to that sufficient for personal requirements only, its production and preparation has come to be among the largest industries of the world, not only furnishing to man textile fabrics in untold variety and perfection of skill, but administering to his comforts in a thousand ways through its varied uses, and at the same time giving him employment and means of livelihood.

The vegetable fibers, in their economic relations, may be divided into six classes, according to their uses, as those suitable for fine spinning and weaving, for coarser spinning and weaving, and for fine cordage; for coarse cordage and unspun woven fabrics, very coarse cordage and mats; for upholstery purposes, and lastly for plaiting or weaving mechanically, as baskets, hats, &c. To make the report more valuable as a work of reference, the complete list of described fibers is here given, the species classified under their appropriate heads to show the economic value of the fiber, and reference made to the families in which they are described, which have been numbered consecutively for the purpose. The initial letters following the names of the species show the extent that the fiber is utilized—whether used in the arts and known as a commercial product, A; used chiefly by natives in the countries where it abounds, N; or prepared only experimentally, or used as a fiber to a very limited extent, E. The figures refer to the families in the body of the report:

ECONOMIC CLASSIFICATION OF FIBERS.

I.—*Fibers extensively employed in the arts, capable of being spun and woven into fabrics of fine texture.*

Boehmeria nivea. China grass. Rhea, 14, A.
Gossypium herbaceum (et al.). Cotton, 2, A.
Linum usitatissimum. Flax, 5, A.

II.—*Fibers that are or may be employed in the arts, capable of being spun and woven into fabrics of inferior durability or coarser texture, and also applicable to fine cordage.*

Abelmoschus esculentus. Okra, 2, E.
Abutilon avicennæ. Indian Mallow, 2, A, slightly.
Abutilon Bedfordianum. 2, E.
Abutilon mollis. 2, E.
Abutilon oxycarpum. 2, E.
Abutilon striatum. Streaked Lantern flower, 2, E.
Abutilon venosum. Veined Lantern flower, 2, E.
Asclepias cornuti. Milk or silk weed, 11, E.
Astrocaryum tucuma. Tucum, 20, N.
Calotropis gigantea. Mudar Yercum, 11, N.
Cannabis sativa. Hemp, 16, A.
Corchorus olitorius and capsularis. Jute, 4, A.
Crotalaria juncea. Sunn hemp, 6, A., N.
Crotalaria tenuifolia. Jubbulpore hemp, 6, A.
Hibiscus cannabinus. Brown hemp, Ambaree, 2, A.
Hibiscus heterophyllus. 2, E.
Hibicus moscheutos. (Swamp rose mallow), 2, E.
Hibiscus mutabilis. 2, E.
Hibicus Rosa-sinensis. (Chinese rose), 2, N.
Hibiscus sabdariffa. Rosella hemp, 2, N.
Hibiscus sorbifolia. 2, E.
Hibiscus splendens. (Hollyhock tree), 2, E.
Hibiscus (Paritium) tiliaceus. 2, N., (West Indies.)
Phormium tenax. New Zealand flax, 22, A., N.
Sida retusa. Queensland hemp, 2, N., A., slightly.
Sida rhomibifolia. 2, A., N.
Sparmannia africana. 4, N.
Triumfetta semitriloba. 4, E.
Urena lobata, Guaxima (Brazil). 2, A., N.

III. *Fibers capable of employment in the arts or used by natives chiefly in the manufacture of cordage, twine, nets, &c., sometimes woven into fabrics or beaten into cloth or "tappa."*

Agave Americana. Pita (century plant), 19 A., N.
Agave Sisalana. Sisal hemp, Henequen, 19, A.
Ananassa sativa. (Pine apple), 18, A.
Apocynum cannabinum. Indian hemp, 10, N.
Bromelia karatas. (See *B. sylvestris.*) Caraguata, 18, N.
Bromelia sylvestris. Ixtle and Istle, 18, A.
Broussonetia papyrifera. Paper Mulberry, 15. N., A.
Cocos nucifera. Coir (cocoa palm), 20, A.
Cocos crispa. Pita de Corojo, 20, N.
Commersonia echinata. Brown "Kurrajong," 3, N.
Cordyline pumilis. (Dwarf palm lily), 22, E.
Daphne tenuifolia. 13, N.
Dasylirion graminifolium. "Bear grass fiber," 18, E.
Dasyanthes excelsa. (Spear Lily), 19, E.
Dracæna draco. (Dragon's blood tree), 22, E.
Eucalyptus obliqua. (Stringy bark), 8, E., (other species, N.)
Ficus ———. (Inner bark), 15, N.
Fourcroya cubensis. Cuban hemp, 19, N.
Lagetta linetaria. Lace bark, 13, N.
Lagunaria Patersonii. (Norfolk Cow-itch tree), 2, E.
Marsdenia tenacissimi. Teetee fiber, 11, N.
Musa paradisiaca. (Plaintain), 17, A.
Musa sapientum. (Banana), 17, N.
Musa textilis. Manila hemp, 17, A., largely.
Pimelia axiflora. 13, N.
Plagianthus betulinas. (The Ribbon tree), 13, N.
Plagianthus pulchellus. 3, N.
Pterocarpus santalinus. 6, E.
Sanseviera guineensis. African hemp, 22, A.
Sanseviera latifolia. 22, N.
Sanseviera zeylanica. Bowstring hemp, 22, N.
Sesbania aculeata. Dunchee fiber, 6, N.
Sesbania macrocarpa. "Colorado River hemp," 6, N.
Sterculia acerifolia. (Flame tree), 3, E.
Sterculia lurida. Sycamore of Australian Colonists, 3. N.
Tilia cordata. (See *T. Europeæ*), 4, N.
Urtica gigas. (Tree nettle of Australia), 14, N.
Yucca angustifolia. Bear grass, 22, N., A., slightly.
Yucca aloifolia. Aloe-leaves; Adam's needle, 22, N.
Yucca baccata. 22, N.
Yucca filamentosa. Also called Bear grass, 22, A.
Yucca gloriosa. 22, N.
Zea mays. (Maize—Indian corn), 25 E.

IV.—*Fibers or bast, chiefly employed by natives in the manufacture of coarse cordage, mats, &c.*

Astelia Banksii. 23, E.
Attalea funifera. Monkey grass, *Pissiaba*, 20, A.
Bauhinia racemosa. (Maloo climber), 6, N.
Bauhinia splendens. (The chain creeper), 6, N.
Bombax Munguba. Embirusu, 3, N.
Caryota urens. (The Jaggery palm), 20, N.
Commersonia Fraseri. "Tye plant," 3, N.
Cordia gerascanthus. 12, E.
Cordia macrophylla. 12, E.
Cordia sebastina. 12, E.
Dianella latifolia. 22, E.
Dombeya Natalensis. 3, E.
Juncus vaginatus. (Sheathed Rush), 23, N.
Kleinhofia hospita. 3, E.
Muntingia calabura. 4, N.
Ochroma lagopus. (Cork-wood tree), 3, E.
Sterculia diversifolia. Victorian bottle tree, 3, E.
Sterculia lurida. 3, E.
Sterculia rupestris. Queensland bottle tree, 3, E.
Tilea europæa. Linden, 4, A., in Russia.
Xylopia sericea. "Pyndayba," 1, N.

V.—*Fibrous material, vegetable hairs, &c., principally derived from seed-pods, suitable for upholstering purposes only.*

Asclepias cornuti. Milk or silk weed (pods), 11, E.
Asclepias ———. (See *A. cornuti*), N., in South America.
Bombax (species). Silk cotton, 3, A., slightly in South America.
Cibotium menziesii. Pulu. (Tree-fern), 26, A., slightly.
Epilobium, sp. (Willow herb), 7, E.
Eriodendron samauma. (See Bombax), 3, A., slightly.
Lyonsia reticulata. 10, E.
Tillandsia usneoides. Southern moss, 18, A.

VI.—*Fibrous material and miscellaneous substances, not strictly "fiber," in manufacture only plaited or coarsely woven, without manipulation, into baskets, hats, mats, &c., or paper.*

Arundinaria tecta. Cane fiber, 25, A., slightly.
Carludovica palmata. (Screw pine), 21, A.
Chamærops (species). Palmetto), 20, A.
Cladium radula. (The black reed), 24, N.
Daphne cannabina. 13, A., slightly, in Asia.
Lepidosperma elatius. Tall sword grass, 24, N.
Lepidosperma flexuosum. Slender sword grass, 24, N.
Luffa cylindrica. Sponge cucumber, 9, N.
Stipa tenacissima. Esparto, 25, N., A., paper.
Spartina cynosuroides. Cord grass, A., paper, United States.
Oreodoxia regia. "Palma real," 20, N.
Pandanus utilus. Screw pine, 21, A.

As will be seen by reference to the list, many of the fibers enumerated have only been experimentally prepared or are in use only by the natives of the countries in which the plants abound, and to a limited extent. Many of these are produced from trees of large size or slow growth, and while the fiber may be of fine quality, and perhaps easily obtained, it could only become a commercial product in proportion to the extent of existing supply.

Many others would in cultivation produce fiber, fine and strong in itself, and useful for many purposes, but which could not compete in the markets with better known fiber for the same purposes. The list, therefore, of really useful fibers, cultivated as a national industry, is named to an exceedingly small number, and in our own country the list is named still smaller (at present), as the question of economical extraction of the fiber is a vital one.

Some of the plants in Group II could be grown successfully in portions of the United States, but the want of an economical and successful means of preparation would prevent the utilization of the product, and hand manipulation is entirely too expensive. Were we all to grow Manila hemp, which is as yet hand-prepared, our laborers are not poor enough to work for 18 cents a day, which is the utmost a native fiber-cleaner can earn (in a day) on the Philippine Islands.

The extraction of bast fiber from the woody stems of *exogenous* plants is attended with difficulty, and no really satisfactory machines have been produced to perform the work. Ramie and jute are still prepared in China and India by the laborious methods of hand manipulation, and it is only the want of machinery that has prevented extensive cultivation of those textiles in this country. With *endogenous* plants, on the contrary, extracting or, rather, cleaning the fiber by mechanical means, seems to be a matter much more easily accomplished; and among those fibers that are already prepared largely by mechanical means may be mentioned New Zealand flax, Sisal hemp in Yucatan, and plantain fiber in the West Indies (see body of report).

Some of the fibers in the above list are only interesting as museum specimens, as showing the various plants producing fibrous substance, or that have been utilized by aborigines in the absence of better material—mostly grown in a wild state, unworthy of cultivation, yet valued locally in their native countries. A few have been prepared experimentally, some with sufficient success to warrant more extended experiment.

The catalogue includes all the fibers and fibrous substances in the museum at present, with the exception of a few Chinese fibers without names, which have not yet been identified.

DESCRIPTIVE LIST OF FIBERS.

That the list may be made more available for reference by the student or inquirer, the plants furnishing the various fibers and fibrous substances here enumerated have been grouped in their natural families, and these arranged in the regular order of classification. By this means the relations of the fibers to each other in the vegetable kingdom, as well as to the various plants producing them, may be noted. Strict generic order has not in every case been followed, plants of the greatest importance having been given first mention in the families to which they belong.

1.—ANONACEÆ.

Xylopia sericea.—Known to the Brazilians as the *Pyndayba;* also called *Malaquete.* The plants of this genus are trees or shrubs indigenous in Brazil and warm districts of South America, and also found in the West Indies. They are noted for the bitterness of the wood and for the aromatic properties of their fruit and seeds.

The fiber of the species named, if fiber it can be called, is of the coarsest description, and consists only of the cortical layers of bark, which are torn from the trees in ribbon-like strips. These have no use that can be dignified by the name of manufacture, and are only rudely twisted or plaited by the natives into a kind of coarse cordage, which is used to tie fences, and sometimes to secure cattle. A sample of this coarsely-twisted rope was received from Brazil (Exhibition, 1876), and is a little more than half an inch in diameter, composed of three strands, each of which contains about nine or ten of these ribbons or strips of bast, the interior ones being quite harsh and woody. Doubtless in skilled hands finer specimens of cordage might be produced, though strictly speaking it does not possess fibrous material. It would be available for mats. *Xylopia fruticens*, known as the *Embria* in Brazil, furnishes a similar fiber. It is also a native of Cayenne. But one species is represented in the collection.

2.—MALVACEÆ.

In this family are included a large number of species of fiber-producing plants, found chiefly in tropical countries, though extending into temperate climates, as the mallow, and marsh mallow, so common to portions of our own country. The genera represented are *Abutilon*, *Hibiscus*, *Sida*, *Urena*, *Lagunaria*, &c. The cotton plant, *Gossypium*, belongs to this family, though cultivated for its capsular fibers and not at all for its bast. It is worthy of note that the cotton plant would produce a strong bast fiber if treated in the same manner as hemp or jute, but of course it would be at the sacrifice of a much more available fiber, *many* times more valuable and useful.

Some of the foreign representatives of this family find their way into commerce, though to a very limited extent, the plants being cultivated. The most prominent of these is the *Ambaree*, grown in India; *Paritium tiliaceum* is much prized in the West Indies; other species have attracted attention in various parts of the world, and even our indigenous species are not altogether unknown. The species are all trees or shrubs with large leaves and conspicuous flowers, and all yield fiber which is valuable for cordage and many other purposes.

Abelmoschus esculentus.—Okra and Okro: This plant, which finds a home in the southern portions of the United States, is a native of the

West Indies* and is as useful as an article of food as for its fibre. Other edible species found in the Old World have been united with it, as *longifolius* of the East Indies, and an African species called *Bammia;* so it may claim a home in both hemispheres. It is cultivated in South France for its pods, and is well known throughout the Southern States as producing a favorite vegetable used largely in soups.

The bark of this species abounds in fiber of fine quality, which can be employed for many purposes. In our own country it has been used to a slight extent in the manufacture of paper, a specimen of which can be seen in the museum in the form of a printed newspaper, from Alabama.

When cultivated for its pods alone, the okra plants are grown at considerable distance from each other, and the strength of the plant goes to develop leaves and fruit, but if cultivated for fiber the seeds should be sown thickly and the plants cultivated closer together, that the stems may grow tall and straight and the bark smooth and better adapted to the production of fiber, which is extracted in the same manner as that of hemp.

In color the fiber is as white as New Zealand flax—whiter than jute as generally prepared for export—but more brittle and of less strength. The filaments are smooth and lustrous, and tolerably regular. Another sample (received Smithsonian Institution, 1869, locality not given), evidently home prepared, as the bast is but little better than separated, exhibits considerable tenacity, and would make quite strong cordage. This sample is 3 feet 8 inches in length. For microscopic characteristics of mallow fiber see *Hibiscus cannabinus*. The okra is worthy of experiment, and its fiber might be used to advantage for many purposes for which jute is employed, as coarse bagging, or baling stuff, burlaps, &c.

In procuring fiber for Dr. Roxburgh's experiments with this species as to tenacity the stems were cut when the seed was ripe, and were steeped a few days before preparing. His tests, compared with hemp and jute, are thus recorded: The okra fiber, dry (from India), broke with a strain of 79 pounds; wet, 95 pounds; jute (*Corchorus olitorius*), dry, 113 pounds; wet, 125 pounds; hemp (Bengal), dry, 158 pounds; wet, 190 pounds. *Hibiscus cannabinum* in the same test gave, dry, 115 pounds; wet, 133 pounds. Other species of Hibiscus gave as follows: *H. sabdariffa*, dry, 95 pounds; wet, 117 pounds; *H. strictus* (from the Mollucas), dry, 104; wet, 115 pounds; and *H. furcatus*, dry and wet, 89 and 92 pounds, respectively.

The species were not all tested under the same conditions, as some were cut when in flower and others when in seed. By these experiments we see that okra fiber wet has just half the tenacity of hemp in the same state, while jute can be rated one-third higher.

Hibiscus moscheutos.—Swamp rose mallow.—An indigenous species of mallow found in many parts of the temperate United States, according to Gray, "inhabiting brackish marshes along the coast, extending up rivers far beyond the influence of salt water (as above Harrisburg, Pa.), also Onondaga Lake, New York, and westward, usually within the influence of salt springs." The plant grows from 4 to 8 feet in height and flowers late in summer.

The value of the plant has been known for many years, though it has never been prepared other than experimentally, and in smallest quantities, from the lack of proper machinery with which to manipulate it, and place it in a condition to be utilized. During the last year the plant

* Porcher states that it was introduced into the Southern States from Africa.

has been the subject of renewed experiment in New Jersey, the better means for the extraction of the fiber, now at hand, having made its successful cultivation probable. In the second report of the bureau of statistics, labor and industries of New Jersey, it is stated that the—

> Recent experiments with the rose mallow at Camden and Newark incline us strongly to believe that jute of equal quality may be obtained from it, and possibly under conditions more advantageous than from the *Abutilon* (*avicennæ*). One very important advantage the rose mallow would have over the Abutilon, in respect to the economy of cultivation, consists in its being a perennial. Like ramie, the plants once established, the annual cuttings from the stands would be a perpetual source of profit to the cultivator, in case the quality and cost of the fiber meet our present expectations.

Although the plant is generally found, in a wild state, in marshes, or upon the margins of streams, or in low wet places, experiment shows that it will thrive upon uplands as well. Twenty years ago rose mallow roots were taken from the place of their natural growth and planted upon uplands on the Delaware River, with a view to utilization of the fiber, and these roots hold their own as tenaciously to-day as when growing in their native swamp. More than this, they have defied attempts at eradication, and continue to grow in spite of opposition.

Samples of fiber produced last year by gentlemen interested in furthering this industry are considered as "a substitute not only for Asiatic jute, but for secondary grades of imported hemps."

Samples of this fiber upon exhibition in the museum are evidently hand prepared, and of very little strength. There is no doubt, however, but that a really good fiber can be prepared from this plant, as well as from allied species which occur from Pennsylvania to Illinois, and southward. It would be interesting to test favorably prepared specimens of the indigenous species of *Hibiscus*, to ascertain their relative strength, though without doubt the northern species would be found inferior to the okra, or species mostly grown in the Southern States. *H. gradiflorus* and *H. militaris* are other indigenous species yielding fiber.

Hibiscus cannabinus.—Hemp-like Hibiscus.—This plant, a native of the East Indies, is extensively cultivated in many parts of India for its fiber, which is employed as a substitute for hemp, under which name it is exported, though sometimes called bastard jute. It has a variety of native names, the most commonly known of which is *Ambaree*, its name in Western India. In Madras it is called *Palungoo*; it is the *Maesta plant* of Bengal, and *Deckanee* hemp of Bombay; the Sanscrit name is *Nálika*. The plant has a prickly stem, the leaves deeply parted, and the stem attains a height of 6 to 8 feet.

Though thriving at all seasons of the year, it is generally cultivated in the cold season. The seeds are sown as thickly as hemp, in rich loose soil, and it requires about three months' growth before it is ready to be pulled for "watering" and dressing, the mode of treatment being the same as that given the Sunn hemp. *Crotalaria juncea* (see *Leguminosæ*). Full-grown plants that have ripened their seed furnish stronger fiber than the plants cut while in flower, though the fibers of this species are more remarkable for their fineness than for strength.

As to uses, a coarse sackcloth is made from its fiber, in India (sometimes called gunny fiber), though its chief employment is for ropes and cordage, it being the common cordage of the country in a few districts. Coarse canvas is also made from it. In Bengal it is employed at the present time for all the purposes of jute, and also for making fish-nets and paper. Vétillart says: "The fiber of *H. cannabinus* is stiff and brittle, and has no superiority over jute, and it is very inferior to that of India

hemp or Sunn." The leaves of the plant are eaten as a pot-herb in many parts of India, the taste being pleasantly acid, not unlike sorrel.

The fibers of carefully prepared *Ambaree* are from 5 to 6 feet long. Compared with ordinary hemp they are paler brown, harsher, adhere closer together, though divisible into fine fibrils, possessed of considerble strength. Its tenacity tested with Sunn is as 115 to 130. The fiber in the present experiment having been extracted from plants cut when in flower.

Vétillart states that the fiber of Hibiscus, when minutely examined in glycerine, appears as a bundle, the filaments strongly united together, so much so that they are with difficulty separated even after treatment in an alkaline solution. The fibers are short, stiff, and brittle; of sufficient fineness, but irregular in size even in the same specimens. The central cavity, usually narrow, is prominent; cells generally terminating in fringed points, sometimes having notches or sinuosities in their outlines; some are large, ribboned, and creased, the exterior surface striated. These last have very slender walls, which explain the creases. Viewed transversely with a high power the fibers are seen to be polygonal, with sharp angles and straight sides, the polygons pressed compactly together. The walls are thick and the central cavity round or oval.

I find no recent quotations of value, the latest being some twenty years ago, when the price compared with other fibers was as follows: Russian hemp, $140 per ton; Hibiscus, $100; and jute, $65. Jute has come into such prominence in late years that its prices would probably range relatively higher. As high as 600 acres of Hibiscus have been cultivated in one district of India for fiber alone.

Hibiscus sabdariffa.—Jamaica Indian Sorrel.—This plant furnishes the "Roselle hemp" of the Madras territories, where it is called "rozelle" or "rouselle," although the name is a corruption of "oseille." It is quite similar to the preceding, and is little cultivated for its fiber. In India its fleshy calyxes, of a pleasantly acid taste, are much employed for making tarts as well as excellent jelly, and in the West Indies for making cooling drinks.

Hibiscus sorbifolia and *mutabilis.*—Both of these species are indigenous in Queensland, from whence the specimens were received (Exhibition, 1876), labelled "Rosella hemp," but incorrectly. *H. mutabilis* is also a native of China, but grows in India and other Eastern localities. Fiber of *H. tetracus* was also received with the above, but does not differ materially.

Hibiscus splendens.—Holly-hock tree.—Fiber from this species, a native of Queensland and New South Wales, was received from Victoria (Exhibition, 1876), prepared by Dr. W. R. Guilfoyle, director of the Melbourne botanic gardens, who states that the species is a splendid tree, growing to the height of 20 feet or more. "It is very pubescent, bearing large pink flowers resembling holly-hocks in size and appearance. The fiber is suitable for cordage, fish-lines, paper, &c.

* *Hibiscus heterophyllus.*—Also a native of Queensland and New South Wales. The fiber was prepared by Guilfoyle from Victorian plants. "This is a tall shrub of quick growth, and the bark is rich in fiber of good quality."

Hibiscus Rosa-sinensis, &c.—There are several other species of mallow fiber in the collection (Smithsonian Institution, 1869), but as they are all so similar in appearance, a detailed description of each is unnecessary. The species are *H. Rosa-sinensis*, the Chinese rose; *H. lilifolia*, "lily-flowered shoe-black;" *H. tetracus* and *H. latifolia*, habitats not given.

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* Species indicated by the asterisk have been separated into the genus *Paritium*. For convenience, however, we will consider them under their old generic names.

**H. elatus*, of the West Indies, incorrectly labeled "Mahoe," is a tree growing to a height of 60 to 80 feet. The *Mahoe* or *Mahaut*, of the West Indies, *H. arboreus*, grows to a height of 16 to 20 feet, and its bark furnishes a superior fiber, which, according to Squier, "is not at all inferior to hemp for most purposes." The fiber is naturally soft and white, and is admirable for the manufacture of paper.

**Hibiscus tiliaceus*.—This fiber, though not in the collection, is worthy of passing mention. It is called *majagua* in Central America and the West Indies, where its fiber is much used for cordage. It is little affected by moisture, and is, therefore, selected by surveyors for measuring-lines. It is the *Bola* of Bengal, and is found throughout tropical and subtropical regions of both continents. The native method of preparing the fiber is to strip the bark from a branch—when a rope or piece of cordage is wanted—and holding one end firmly between the toes, first tearing it in strips, it is twisted by the hands. "It was generally cultivated in America prior to 1492."

Abutilon avicennæ.—Indian Mallow.—This is another malvaceous plant that has been cultivated in the United States to a limited extent. It is an annual, usually growing to the height of 4 feet, though in cultivation stalks 6 feet high are common, and Professor Waterhouse records a height of 8 feet in Missouri. Gray states that it was introduced from India, and when found in a wild state has escaped from cultivation. It grows so freely upon any rich soil, even thrusting itself in and growing spontaneously, that it has almost come to be considered a farm pest in many portions of the country. It grows luxuriantly throughout the West and North, the line of States from Ohio to Missouri producing even now vast quantities of the fiber, which rots and goes to waste upon the stalks every year. The fiber is strong, glossy, and white, and the ligneous body of the plant gives more cellulose for paper stock than many other species. Mr. Lefranc considers it superior to Indian jute, and finer than Manila hemp, and he classifies it, in value, between Manila and Italian hemp.

> Extracted from the plant in its young stage, it would be fine enough for textile fabrics, such as carpet-yarns and fillings. It takes readily any colors, and its natural luster displays more in the aniline dye than in any other, a great advantage over Indian jute, which is antagonistic to cheap bleaching and dyeing.

The seed of the plant is so hardy that it is not affected by the severest winter. Within a few years efforts have been made to introduce the fiber into commerce, and to that end it has been the subject of experiment, both as to cultivation and manufacture, with results to a certain degree satisfactory, though perhaps the high standard of excellence that has been claimed for it by enthusiastic experimenters has hardly been realized.

Fully ten years ago it attracted considerable attention in the West, and particularly in Illinois, through the endeavors of Mr. J. H. McConnell, who demonstrated its value by manufacturing it into thread, cordage, rope, &c. A State fair committee in 1871 reported upon these manufactures, and stated that the fiber gave flattering promise of utility. According to this report the plants are stated to grow 9 to 14 feet high; that the seed should be sown 12 to 16 quarts per acre, in corn-planting time, in the same manner as hemp; that it is cut with a reaper, shocked like hemp till cured, then water-rotted like hemp; a volunteer crop will spring up the last of July, which can be dew-rotted. The cost of cutting is given at 75 cents per acre; water-rotting, $10; dew-rotting, $5; hand cleaning, $12; and half as much by machinery, making the total

*Species indicated by the asterisk have been separated into the genus *Paritium*. For convenience, however, we will consider them under their old generic names.

cost, not including rent of land, $19 to $31. Messrs. McConnell offered $100 per ton for all water-rotted that could be furnished, and $75 for the dew-rotted. The crop is not exhausting to the soil if the refuse is restored to it.

In the last two years it has been the special subject of investigation and experiment in the State of New Jersey, through the endeavors of Mr. Samuel C. Brown. A circular was issued in 1878 for the twofold purpose of awakening an interest in the subject of fiber cultivation, and to ascertain what portions of the State were best adapted to its cultivation. From their investigations and experiments, it is settled that there really need be no difficulty in fiber cultivation, the material point being to ascertain the best conditions under which to convert hitherto uncultivated plants into those of future industrial significance and profit. Mr. Brown, in his first report* on the subject of Abutilon fiber cultivation, says:

It must be remembered that success in this new field of enterprise is dependent upon the cost of the product. Unless we can substitute mechanical appliances to offset the cheap labor of India, we cannot hope to attain success in producing jute fiber. But we need not entertain doubts in reference to future mechanical achievements in manipulating either jute † or ramie filaments.

These industries are advocated in the interest of the public, hence every encouraging feature pertaining thereto should be disclosed. We have had two interviews with importers of jute, with samples of New Jersey jute fiber in hand. We sought these interviews with the view to determine, by *unfriendly* criticism, the character of the domestic article. The gentlemen were informed of the circumstances under which our samples were prepared, with the further assurance that they were not equal to what would be produced from the same garden plants later in the season. The quality, however, was pronounced to be very good, and, furthermore, that if we "never produced anything better than that our country had something of great value;" and still further, that "America would become an exporter of jute." The other gentleman we subsequently met, who is engaged in the jute trade, and a resident of Calcutta, after examining with the deepest interest our specimens of jute (*Abutilon avicennæ*) and ramie, had the kindness to say, "I would not be surprised if you did succeed in producing jute some day." The value of this concession was greatly enhanced by the indescribable disinterestedness with which it was announced.

It is stated that an acre of ground will produce 5 tons of Abutilon stalks, and about 20 per cent. of pure fiber is obtained after preparation. Considered superior to jute fiber as imported, the long fiber is fully equal in value to Calcutta prime jute, and Philadelphia rope manufacturers have already offered to buy any quantity at the highest market price for jute. Bleached and cottonized for fabrics, Mr. Lefranc pronounces the Abutilon fiber good for weaving tissues and for mixing with a certain class of woolen goods. *Abutilon avicennæ* in its crude state is worth from $8 to $10 per ton. In regard to its preparation the authority above quoted says:

In India, jute is rotted in water and separated by hand from the ligneous body. This method cannot succeed in America. As with ramie, machinery and chemicals must be substituted for the production of American jute (Abutilon). As explained in the case of ramie, the jute industry can be most successfully established by organized agencies through which farmers could sell their raw crops by the ton. At $10 per ton for dried stalks in proper shape, the grower and the manufacturer could realize, respectively, legitimate profits from the new industry. * * * We have more inducements to embark in the production of jute than the East Indian had. The superiority of our staple, the mechanical facility for treatment, and the ready home market, now supplied by the foreign article, open the road for successful enterprise in the development of this new industry.

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* First annual report of the bureau of statistics, labor, and industries of New Jersey.

† By "jute," *Abutilon avicennæ* is meant. The application of the name "American jute" to the Indian mallow seems somewhat out of place, as the term should be used only to designate fiber from the jute of commerce (*Corchorus olitorius*) grown in our own country. Should such cultivation ever be attained, "American jute" will then be most appropriate.

As I have stated, the plant grows readily in any rich soil suitable for corn or potatoes. Its seed is so tenacious of vitality that frosts do not injure it, while it sows itself and even encroaches, year by year, upon contiguous land to that upon which the plants are cultivated. Viewed as a farm-weed merely, this habit makes it troublesome, though it establishes the fact of ready cultivation. This point being settled, the only remaining question relates to the preparation of the fiber, which must be cheaply accomplished, and in a manner that will give the least trouble to the farmer, as there are few who would go to the trouble or expense of preparing pools for steeping the crude product, as is the custom with jute in India or flax in other countries. Mr. Brown mentions in a recent report (see appendix, Article I) that, from experiments made in 1879, it is thought that the steeping or rotting process can be dispensed with entirely, and that the labor expended upon this crop by the farmer will be no greater than attends the growth of wheat or rye.

Professor Waterhouse, of Washington University, Saint Louis—an authority upon all questions pertaining to jute and allied fibers—writes that, in his opinion, the cultivation of the *Abutilon avicennæ* for its fiber is susceptible of development into a source of great wealth to the country. In reply to a request for recent facts touching its usefulness as a fiber plant, I received from him a manuscript copy of a letter* written to Mr. Brown upon the same subject, with the privilege of publication. As it contains much interesting and valuable information, I gladly reproduce it entire in the appendix.

The important question of machinery for the preparation of this, as well as other vegetable fibers, has received a partial solution in the efforts of Mr. Lefranc, of Philadelphia, and Mr. A. Angell, of Newark, N. J. The Lefranc ramie machine, fully described in the annual report of this department for 1873, is found available for this class of fibers, and during the entire summer of 1879 its inventor was engaged in experimenting with the Abutilon fiber, with a view to discover new methods of treatment. Mr. Lefranc believes that his efforts have resulted in the discovery of "a combined chemical and mechanical process by which the intrinsic and industrial value of jute (Abutilon) can be greatly enhanced at comparatively small cost. The practical advantage of this refining process consists in obtaining a vegetable wool, which is so nearly akin to coarse animal wool as to render their union in coarse fabrics advantageous, and for additional possible uses by itself a valuable substitute." The Angell machine is of quite recent invention, having been patented September 16, 1879. Mr. S. C. Brown informs me that it does its work in a very satisfactory manner, and he thinks it a valuable invention. He makes the further statement in a recent report that "it has achieved such results as to entitle it to public recognition as being in the line of devices for promoting the fibrous industry."

A bounty bill to encourage the production and treatment of fibers in the State has passed the legislature and become a law. There is a clause in it which relates to the Abutilon, called "American jute," in the bounty bill. (See appendix.)

Douglas Hickox, of Springfield, Ill., has had patented an improved process for manufacturing paper from Abutilon. (Issued May 1877.) A mill was started in Springfield previous to the invention of the process, and several thousand tons of the fiber was worked up, but a merchantable paper could not be obtained. Subsequently the process mentioned above was introduced into the mill, and Abutilon paper was manufactured for about eighteen months, after which the fiber was abandoned,

* Since the above was written it has appeared in print in the second report of the New Jersey bureau of statistics, labor, and industries.

and straw used in its place. A series of paper samples submitted for inspection are fair wrapping papers, resembling a light manila more than anything else. The paper is clear and of firm texture; samples of flax-straw paper were also included, with a very good specimen of paper from wheat straw, called "bogus manilla."

There is a small series of samples of Abutilon fiber in the museum, showing it as extracted, and also dyed to exhibit the facility with which it takes colors. The fiber has been used to some extent in the manufacture of cordage and twine. Specimens of rope exhibited at the last New Jersey State fair carried off the prize of $100 for the best textile products of the State.

Mr. Hickox states that a factory was started in Springfield, Ill., a few years ago for the manufacture of rope and small cordage, but from some cause unknown to the writer the project was abandoned. Samples of twine forwarded seem strong and good.

Another use to which the fiber was put, though only to a limited extent, was in the manufacture of a substitute for feather dusters, a few stiff feathers being inserted in a handle in the center of a mass of fiber to hold it out in the form of a duster. Other fibers, as hemp, are used for the same purpose. I have had no opportunity to examine manufactures from New Jersey grown Abutilon, though the samples of fiber shown me by Mr. Brown seemed very strong and good.

The specimens in the museum are not equal to okra fiber, and the material is quite brittle, so much so that when used as a brush or duster they make almost as much dirt as they are supposed to clean away.

The fiber is used for making paper to some extent in the West.

Abutilon mollis.—In the Victorian collection (Exhibition, 1876), there are four species of *Abutilon*, which have been introduced into Victoria from South America. Like other malvaceous plants, they are all fiber-producing, and might prove worthy of cultivation. Dr. Guilfoyle says of this species, "though a native of South America, the shrub is of exceedingly rapid growth in Victoria. Its fiber is very strong and suitable for matting, paper," &c. The sample has been carelessly prepared and is not of good color, nor are the fibers well separated. It is never quite strong, and in general characteristics resembles that of its allied genus *Hibiscus*.

Abutilon Bedfordianum.—Habitat, Brazil.—Victorian collection of Guilfoyle. "A tall, rank-growing shrub, of very rapid growth in Victoria. The bark yields a fiber of superior quality, suitable for whip-cord, fine matting, paper, and perhaps textile fabrics." The fiber has been much more carefully prepared than the preceding. It is almost white, the filaments fine and regular, and possessed of considerable tenacity.

Abutilon venosum.—Veined Lantern Flower.—This is also a native of Brazil. Victorian collection of Guilfoyle. "Fiber of fine quality, suitable for fishing-lines, textile fabrics, and paper." Resembles the preceding in color and fineness, though appears to be stronger.

Abutilon striatum.—Streaked Lantern Flower.—This is the species so commonly met with in greenhouses in winter, and growing out of doors (in this latitude) in our gardens through the summer. The plant is a native of Brazil. The sample of fiber is from Victorian collection. "Its bark, which peels readily, furnishes a fiber of very fine texture." As this plant grows so readily out of doors in the warmer portions of the United States, it might be worthy of experiment, as the fiber is fully as strong as the preceding, and could be obtained in considerable length, as the shrubs grow to the height of 4 to 6 feet, and, as its bark peels readily, could be easily extracted.

Abutilon oxycarpum.—This species appears in the Queensland collection (Exhibition, 1876), in which country it is indigenous. The sample is well prepared, quite white, the fiber soft and lustrous, and appears a little stronger than the Victorian sample. *A. indicum* and *polyandrum* are East Indian species, which furnish a strong fiber for rope-making, the first named growing wild in the Bancoorah district, and used as a substitute for cordage in making fences for gardens, but for no other purpose.

Sida retusa.—Queensland hemp.—Sida is another genus of malvaceous plants growing extensively in the more tropical portions of both hemispheres. Some of the species abound in mucilage, while the bark of others is rich in fiber. The fiber sample was received from Queensland (Exhibition, 1876), labeled "Queensland hemp," and was accompanied by another species, *S. rhombifolia*, the label of which states that this plant "is called *Sida retusa*." A fine sample of *retusa* fiber was received with the Victorian collection, labeled Queensland hemp, which was prepared by Dr. Guilfoyle, who states that the plant has established itself in Melbourne, and is of very quick growth, seeding freely. He regards the fiber as suitable for fine paper, and for the manufacture of cordage.

The sample of "*S. rhombifolia*" is very white and lustrous, the filaments fine and even; in a portion of the sample the ribbon-like character of the bark is retained, filled with delicate indentations, giving it a lace-like appearance. These ribbons of fiber break easily, but a twisted cord of the finer prepared fiber, the size of cotton wrapping-twine of the shops, broke only after repeated trials with the hands. The fiber was prepared by Alexander McPherson. This species grows in India, and the bark yields "abundance of very delicate flax-like fibers", which Dr. Roxburgh thought might be advantageously used for many purposes. Forbes Watson, in the Descriptive Catalogue of the East Indian Department, International Exhibition, 1862, pronounces the fiber similar to jute in appearance, "but considered to be intrinsically so superior that it is worth from £5 to £6 more per ton, and he places it next that fiber" in order to attract to it the attention which it deserves.

Experiments with the fiber of *S. rhombifolia* demonstrated the fact that a cord one-half inch in circumference would sustain a weight of 400 pounds. In speaking of Dr. Roxburgh's specimens, Royle says "the fibers are from 4 to 5 feet in length, and display a fine, soft, and silky fiber, as well adapted for spinning as jute, but infinitely superior." The specimens of Queensland hemp in the department collection are very well prepared, and quite strong; the fiber, in color, is grayish-white. The Victorian sample, while strong, is dark colored, and has been poorly cleaned.

S. periplocifolia, a native of the Malay Islands, furnishes a serviceable fiber, and *S. tiliæfolia* is cultivated by the Chinese for its fiber, which they consider superior to hemp. The Chinese name for the plant is *King ma*.

Urena lobata.—Urena is another genus of Malvaceæ, consisting of a few extremely variable species extensively distributed over the tropics of both hemispheres.

Fiber of *U. lobata* was received from Brazil (Exhibition, 1876), where it is known as *Guaxima*. The fiber is extracted readily, and makes very strong cordage. It also takes color well, and the dyes are lasting. In India, where the species also abounds, it is called *Bun-ochra*, and produces a strong fiber, "a tolerably fine substitute for hemp," though an English authority regards the fiber as nearer resembling jute than either flax or hemp.

In the East Indies they have recently begun the manufacture of paper

from the *Guaxima* of Brazil with good results. Two finely-prepared samples were received; the fiber is light in color, the filaments quite fine, even, and strong, and might be spun. It resembles finely-bleached specimens of hemp rather than either flax or jute. A piece of twine twisted by hand to about the size of pack thread I was unable to break with the fingers.

Urena sinuata, another species, Royle mentions as common in most parts of India, producing good fiber. This species is also represented in the collection of the department (Smithsonian Institution, 1869).

Lagunaria Patersonii.—Norfolk Cowitch Tree.—This beautiful shrubby tree is indigenous in Queensland and Norfolk Island, and is closely related to *Hibiscus*. The fiber sample was prepared by Dr. Guilfoyle (Victoria Exhibition, 1876), who accompanies it with a statement that it is suitable for manufacturing paper of a superior quality, samples of which were also presented, and for ropes, strong cordage, fine matting, and basket work. The fiber is fine, strong, and glossy, although the specimen can hardly be said to compare with *Sida rhombifolia* in any one of these particulars.

Gossypium herbaceum.—Cotton.—This most important of all fiber plants also belongs to the *Malvaceæ*. There are several distinct species, as *G. herbaceum*, *arboreum*, *sandwicense*, *taïtense hirsutum*, *barbadense*, *religiosum*, &c., and many different varieties. The first-named species is generally accepted as the species most commonly cultivated in the United States and North America. The origin of the cotton-plant is a question not easily settled, as cotton has been grown in many countries from an exceedingly remote period. It is probable that a plant numbering so many species is indigenous in different localities, though Rhind states that it may possibly have come from Persia originally, then crossed into Egypt, thence to Asia Minor and the Indian Archipelago. M. Bernardin, curator of the Industrial Museum of Ghent, in his "*Nomenclature Uselle de Fibres Textiles*," gives the origin of the several species named, crediting at least two to North America, *G. barbadense* from the West Indies, and *G. hirsutum* from Mexico. *G. herbaceum* he regards as originally an East Indian species. These are points, however, upon which authorities differ widely, and therefore we are left only to conjecture.

Its Arabic name is *Goin*, *Kotan*, or *Kutn*. In Persia it is called *Pembeh*, or *Poombeh*. It is known as *Cay Haung* in China, and *Watta ik* or *Watta noki* in Japan. In Bengal it is *Kobung*; in Siam *Tonfai*, while its Tahiti name is *Vavai*. The ancient Mexican name for the plant was *Yehcaxihitvitl*. These are a few of its many native names, the long list that might be given showing how universally the plant is in cultivation.

Porcher states that cotton was first cultivated in the United States as an experiment in 1621, and that it is a native of tropical America. According to Prescott, in the "Conquest of Mexico," the Spaniards found it in that country, and it is also affirmed that the ancient Mexicans "wove cotton garments stained with the most vivid and brilliant colors, an art practiced by the Aztecs, but now entirely lost." There are records that cotton was cultivated in South Carolina as early as 1666, though it does not seem to have become a matter of export for nearly a century after. It is recorded that "7 bags" were exported in 1748. The first importation of raw cotton into England from the East Indies was in 1798. Although cotton has been cultivated in China for over 2,000 years (and perhaps for a longer period), its introduction into Japan is of comparatively recent date, it having been brought from the first-named country between 1558 and 1570, A. D. Cotton is cultivated to some extent in Southern Europe, and formerly Italy produced vast quantities, but the industry has dwindled to almost nothing.

To return to our own country. One hundred years ago, before the invention of the cotton-gin, when the crop was scarcely more than an experimental product, more curious than useful, the rare adaptation of soil and climate of the Carolinas and Georgia to the growth of this valuable textile was clearly demonstrated. The more western States of the cotton belt were little known, yet generally believed to be also suitable to its production. So difficult and slow were the rude processes employed for separating the seed from the lint that it was only grown for supply of clothing of domestic manufacture for the poorer classes, though its cultivation had been commenced a century and a half before, for "cotton wool" of native growth was quoted in 1621 at 8*d*. per pound. Carroll mentions the growth of cotton in South Carolina in 1666. In 1734 cotton seed sent from England was planted in Georgia, as a great interest was felt in the mother country in the cotton experiment. In 1742 a French planter in Louisiana, M. Dubreuil, invented a machine, a rude contrivance similar to the ancient India mill, which worked by hand, consisted of two fluted rollers, revolving nearly in contact, through which the lint was drawn, while the seeds, too large to pass through the opening, were left behind. Another invention is credited to M. Crebs, of Florida. Neither of these prepared the fiber for use, and another contrivance was employed, a bow, with a combination of strings, which were struck by a wooden mallet as the implement was placed in contact with a heap of cotton, opening the knots of fiber by its vibrations, shaking out dirt and dust, and raising it to a downy fleece. And this "Georgia bowed cotton" began to be quoted in trade lists of Liverpool, as the small surplus gradually sought a foreign market.

The invention of Eli Whitney, in 1793, was sufficiently early, as the first steam-engine for a cotton-mill was not made till 1785, and up to 1800 the number in use was only 32, of 430 horse-power. Exportation from this country had commenced, 189,316 pounds being shipped in 1791, less in the following year, but in 1793 the shipments were 487,600 pounds, and in 1794 they reached 1,601,700 pounds from the impetus given by Whitney's gin. The figures jumped to six millions the following year, and to nine in the closing year of the eighteenth century. Then the advance was rapid, from 17,000,000 pounds in 1800 to 93,000,000 in 1810, and 127,000,000 in 1820. The official records of British imports show that the largest importation from the United States was in 1860, when it reached 1,115,000,000 pounds, and the largest proportion of total imports was in 1845, or 86.8 per cent. The proportion fell to 1 per cent. in 1863, when the little that was grown was under the embargo of civil war, but has risen since with astonishing rapidity until more than three-fourths of the British consumption is furnished by this country. Without giving in detail this wonderful industrial history, the progress of exportation may be seen at a glance in the following figures:

Years.	Total imports.	Imports from United States.	Per cent. for United States.
	Pounds.	*Pounds.*	
1840	[illegible]	487,856,504	82.3
1845	[illegible]	626,650,412	86.8
1850	[illegible]	493,153,112	74.3
1855	891,751,952	681,629,424	76.4
1860	1,390,938,752	1,115,890,608	80.2
1865	978,502,000	135,832,480	13.9
1870	1,339,367,120	716,248,848	53.5
1875	[illegible]	[illegible]	[illegible]
1878	1,340,380,048	1,026,190,928	76.5

If the manufacture of cotton has had a rapid development in Great Britain, more than doubling its consumption of material in forty years, that of the United States has increased in large proportion, as the following statement shows:

Year ended August 31—	Taken by home manufacture.	Exported to foreign countries.
	Bales.	*Bales.*
1850	562,769	1,590,155
1860	964,628	3,774,173
1870	895,890	2,178,917
1879	1,586,960	3,467,565

It was popularly held in the South, as late as a dozen years ago, that this country could never again produce a crop of 5,000,000 bales, yet it has twice exceeded 5,000,000 bales, and the last three crops have surpassed in weight the largest ever grown prior to 1860. The requirements of cotton manufacture are steadily increasing, and can be easily met by the production of this country, even though 10,000,000 instead of 5,000,000 bales should be needed. Probably not more than 13,000,000 acres are occupied in this culture, or 7 per cent. of the area of the State of Texas. One-tenth of the number of counties in which this textile is grown at all now produces nearly half of the crop, and only a comparatively small portion of the area of these counties is under cotton culture. The average yield rarely reaches 190 pounds per acre, and could easily be doubled. For every bale of cotton there is nearly a half ton of seed, and nearly 2,000,000 tons of seed are now wasted, for its partial use as a fertilizer is little better than waste, in view of the fact that 20,000,000 of sheep might be annually fed with the unutilized seed, and the inexpensive green-feeding that would be required to supplement it. The cotton States can supply Europe with mutton and cotton from the same fields, and diminish rather than increase the area now required for the fiber alone.

The increasing use of labor-saving implements is cheapening the cost of production; the judicious use of fertilizers, especially in composts with the waste material of the farm, tends to the same end by swelling the rate of yield. Both of these ameliorations act as an inducement to enlarge the proportion of white labor, which now produces nearly half the cotton crop, and in the country west of the Mississippi decidedly more than is grown by black labor. This fact illustrates the opening of a mine of productive power and ultimate industrial wealth.

Another source of Southern wealth to be garnered in the future (and in the near future if present advantages are improved) exists in cotton manufacture. Already is begun the profitable manufacture of yarns on the plantation or in little neighborhoods of "ten-bale men," by the Clement attachment or similar process, by which cards are attached to a gin, and baling, hauling, commissions, long freightage, and opening and picking the fiber at the factory are all dispensed with. Already factories that are producing cottons both coarse and fine are paying dividends that would delight the Northern or European manufacturer. Soon the yield will reach 6,000,000 bales. Let the cotton States consume 2,000,000, the Northern States an equal amount, and the European competition for the remainder will insure prices that will be steadily remunerative, while the proceeds will become accumulated capital instead of funds compulsorily employed in lifting annually recurring

mortgages. Labor, now unemployed and sadly needing its wages for the social and material advancement of a large class, will find steady and remunerative engagement, new industries will be introduced, education advanced, social order improved, home comforts increased, and peace and plenty will smile as never before upon a sunny land.

The mode of cultivation and preparation of so well known a fiber in our own country can hardly claim a place in a brief and condensed report upon fibers in general, though its microscopic features may be of interest. Examined longitudinally, cotton fibers appear in the form of ribbons, either flat or twisted spirally, corkscrew fashion, and are easily detected when mixed with other fibers. Upon the margins of these ribbons swellings are observed, somewhat as though the edges were rolled over, and these margins—narrow in comparison to the width of the ribbon—indicate that the walls of the fiber the thickness of which they represent are slight. Creases are sometimes observable in the walls either parallel to the axis of the fiber, in an oblique direction, or undulated, which may be taken for slits or breaks, but close examination reveals that their edges are not sharp and clear like the fissures of flax fiber. The ends are generally large and round. Viewed transversely, the fiber is very characteristic. The filaments are always isolated, never grouped or joined together, and in form are round, oval, or elongated, often folding upon themseves at the ends, giving a kidney shaped appearance, while others are convoluted into forms resembling the letter S. The interior cavity, seen in the form of a line, takes the same shape as that of the fiber, when viewed in cross section.

The museum collection is quite large. The series commenced in 1864-'65 with specimens gathered from various localities at home and abroad, and in a few years embraced the principal varieties grown at the time. The samples were quite small, however, with some exceptions, and in 1875, when it was determined that the museum should be represented at the Exhibition, a larger and more complete collection was made by direct appeal to cotton growers throughout the country. This collection was returned to the department at the close of the Exhibition in Philadelphia, and now forms the principal exhibit in the cotton collection of the department. It includes favorite varieties, among which may be mentioned Egyptian, Dickson, Improved Peeler, Tumel maki, Goosey, Hurlong moina, Hunt seed, Old Petit Gulf, Texas Prolific, Texas Wool, McShawn (the last named from a $1,500 prize bale, Saint Louis fair, and grown at Rienzi, Miss.), Improved Remessis, Zippora, &c. The seed of the different varieties also accompanies them. These samples are followed by a complete series illustrating the (American) manufacture of cotton goods in 10 stages or processes, with samples of the various fabrics for which cotton is employed.

Among the foreign samples, a series of over forty specimens exhibits the sources of the cotton supply of Great Britain during the late war, with species attached. Other finer specimens of foreign cottons have been received from time to time from Asia and the South Sea Islands, including tree cotton lint, nankeen, and other curious forms. The largest series of foreign cottons was added in 1876, at the close of the Exhibition, and embraces fiber from the various cotton-growing sections of the world. The most extensive donation was a pair of large cases filled with specimens of cotton and cotton manufacture from the imperial mills in Japan, of which there are two (located near the cities of Tokio and Osaka), which are provided with foreign machinery. These samples include raw and spun cotton in all processes of manufacture, with yarns of various colors to show the mode of dyeing. Egypt presented a col-

lection of over 400 samples. From some of the Australian colonies representative collections were received, as also from the Fiji Islands and islands of the South Pacific. Russia is represented by samples from Turkestan. Spain presented a few samples, and the Portuguese collection is quite full. The South American cottons are from Brazil, Peru, Chili, Argentine Republic, and Venezuela, and include a number of samples of nankeen or red cotton. From Mexico, "where cotton is one of the most natural and successful growths," samples were received as produced in nine states. The Mexican cotton is consumed at home. These extensive collections with the fine series of home production forms one of the most complete and valuable collections that could be well gotten together.

3.—STERCULIACEÆ.

This is a large family of tropical South African or Australian shrubs, trees, or herbs, many of them furnishing fiber having somewhat the appearance of malvaceous fiber. The specimens included in our list are all from trees, natives of Australia.

Sterculia acerifolia.—The Flame Tree.—Nearly all the species of this genus are trees, many of them of large size, and most abundant in Asia and the Asiatic islands. They are also found sparingly in America, Africa, and Australia, and for the most part inhabit tropical countries. The inner bark of the *sterculias* is composed of tough fiber which is not affected by wet.

S. acerifolia is a native of New South Wales, and is a lofty tree. Dr. Guilfoyle states that the bark is fully two inches thick when the tree is full grown, and furnishes bast of a most beautiful lace-like texture. The fiber is very shaply prepared by steeping, and is suitable for cordage and nets, ropes, mats, baskets, &c., and is useful as a paper material. The tow is of a very elastic nature, and is suitable for upholstering purposes, such as stuffing mattresses or pillows. The specimens were received from Victoria (Exhibition, 1876), and were prepared by Dr. Guilfoyle.

Sterculia diversifolia.—The Victorian Bottle Tree.—This species is a native of Victoria, and is a stout, glabrous tree, having a peculiar bottle-shaped trunk. The bast is similar to that of *S. acerifolia*, but coarser in texture. The fiber is suitable for coarse ropes and cordage. It would also make fine matting, and could be used as a paper material. From Dr. Guilfoyle, Victorian collection.

Sterculia rupestris.—The Queensland Bottle Tree.—A native of Queensland, where the tree attains a considerable height, and has an enormous bottle-shaped trunk, from which it derives its name. Its bark is thick and strong, and can be used for the same purposes as the other species. Dr. Guilfoyle, Victorian collection.

Sterculia lurida.—"Sycamore" of the Colonists.—This species is a native of New South Wales. The tree is of large size, resembling *acerifolia* in appearance. "Its bark is a valuable fiber-yielding material." In New South Wales it is made up into a variety of fancy articles by the colonists. The fiber is the inner bark of the tree, and when freshly stripped has a lace-like character which adapts it for fancy work. Dr. Guilfoyle, Victorian collection.

Sterculia fœtida.—This species, a native of New South Wales, is also indigenous in the East Indies and the Malayan Peninsula. The fiber is similar to the preceding, and is manufactured into mats, bags, cordage, and paper. *S. quadrifida* is another New South Wales species, also represented in Dr. Guilfoyle's collection. *Sterculia villosa* is a native of

India, and is called *Oadal*. Ropes are made from it, used in elephant hunting. In Goa and Canara capital bags are made by soaking logs of the trunk or large branches for a few days in water, and then stripping off the bark entire and sewing up the bottom.

Royle states that this tree is very common in India, and the rope is made most readily. The bark, or rather all the layers, can be stripped from the bottom to the top of the tree with the greatest facility, and fine, pliable rope is made from the inner layers, while the outer ones yield a coarser rope, which is strong and durable and little injured by water.

Compared with jute, according to Dr. Roxburgh's experiments, sterculia fiber (*S. villosa*) stood a strain of 53 pounds, against 68 pounds for jute, *Corchorus olitorius*—*C. capsularis* sustaining one pound less. *S. Guttata* is used on the Malabar coast for the manufacture of clothing.

Plagianthus betulinus.—The Ribbon Tree.—The species of this small genus are confined to South Australia, Tasmania, and New Zealand. The species named is a graceful tree, attaining a height of 70 to 80 feet. Dr. Guilfoyle states that the tree is frequently called the "Lace Bark Tree." Its bark is of a beautiful lace-like texture, tearing into shreds with the greatest ease, but flexible and strong. The tree is called *Akaroa* by the New Zealanders, who extract a fibrous material from the young branches, known as New Zealand cotton, which is not only fine but exceedingly strong, though resembling flax or hemp rather than cotton. The fiber of the Ribbon Tree is utilized in the manufacture of fishing lines and nets, and to some extent cordage and paper. The fiber of this and the following species was received from the Victorian collection (Exhibition, 1876) and was prepared by Dr. Guilfoyle.

Plagianthus pulchellus.—This species is indigenous to Victoria, where it is found growing extensively on margins of creeks and rivers, in the form of a tall shrubby tree. It yields a fine strong fiber sometimes called Victorian hemp, which is considered suitable for whip-cord, fishing-lines, nets, fine matting, and paper.

Ochroma lagopus.—Cork Wood Tree.—A sample of fiber from this plant was received from the West Indies through the Smithsonian Institution (1869). The tree producing it is the well known Cork Wood of Jamaica. It grows to the height of 40 feet, and is found exceedingly common in the West Indies and Central America, particularly on the coast. It is called *Balsa*. On account of its light and spongy wood, it is used quite extensively for rafts and for floats of fishing-nets.

The fiber is an ocher-red in color, is very coarse, and of little strength, though it might, if easily obtained, be useful for mattings and cordage requiring little strain. Its fruit or pod produces a silk cotton similar to *Bombax*, which is used for upholstering purposes. In Venezuela this substance is sometimes used for stuffing, but is regarded as of little value, the fiber being short and so smooth and round (like *Asclepias* down) that it will not felt.

Kleinhofia hospita.—This specimen is similar in appearance to Ochroma, and of so slight tenacity that it can only be mentioned as fibrous material. The species is a low branching tree, a native of the Malay Archipelago, extending eastward to the Solomon Isles. Its bruised leaves are said to exhale a perfume similar to that of the violet. The genus consists of but the one species. (Specimen received Smithsonian Institution 1869.)

Bombax (species).—"Silk Cottons."—There is quite a large series of silk cottons upon exhibition in the museum, principally from South America, the oldest samples having been collected by Lieutenants Hern-

don and Gibbon when exploring the Valley of the Amazon, and the more recent obtained from various countries in South America represented at the Philadelphia Exhibition. The "fiber" is soft and flocculent, like thistle-down, and is formed in a pod somewhat similar to that of *Asclepias*. The filaments are short, straight, and smooth, and have no felting properties whatever; nevertheless, the fiber has been spun and woven in India, experimentally, a very good coverlet having been made out of it. It has also been made into cloth, but nothing could be done with it upon cotton-spinning machinery, from the shortness of its staple and its great elasticity. In Brazil and the Argentine Republic it is used for upholstering purposes. Royle suggests that it might be converted into half-stuff for paper making, or perhaps used in the manufacture of gun-cotton.

The species of *Bombax*, of which there are about a dozen, are soft wooded trees confined to the tropical portions of the American continent. The fruit is a large woody capsule, containing numerious seeds arranged in five cells, each seed being surrounded by a quantity of soft silk-like hairs. When ripe the pod bursts into five sections, and the seeds are carried away by the winds.

Bombax munguba is found on the Amazon, and is a tree of 80 to 100 feet in height, while *B. pubescens*, called *Embirussu*, found in the province of Minas Peraes, attains a height of 25 to 30 feet. It is worthy of note that the last-named species has a tough, fibrous bark, which yields quite a strong fiber resembling jute in color, which is very useful for making ropes and cordage. In a small "Catalogue of the Products of Brazilian Forests," by José de Saldanha da Jama (Exhibition, 1876), it is stated that the bark of the trunk of *B. munguba* furnishes fibrous material for coarse rope, as well as vegetable silk from its pods. *Chlorisa speciosa* and *Eriodendron samahuma* are also mentioned as producing vegetable silk. The last named is "the largest tree of the Amazon, and the fruit contains a silk much sought for mattresses."

Commersonia Fraseri.—"Tye plant" of Australia.—The plant producing this bark fiber is a native of Victoria. It is a tall shrub or small tree, and abounds on the banks of rivers and creeks. The bark is used extensively by the settlers as a tying material. It yields a fine fiber suitable for matting and cordage, and a good quality of paper could doubtless be made from it. The specimen was obtained from the Victorian collection (Exhibition, 1876), and was prepared by Dr. Guilfoyle. The fiber is quite dark, due probably to insufficent bleaching, but is strong and not very brittle; and, although the filaments are stiff, they exhibit under the magnifying glass a very fibrous nature, some of them being fine and lustrous; is inferior to Hibiscus fiber. The sample measures between 2 and 3 feet in length.

Commersonia echinata.—A sample of this fiber was secured from the New South Wales Exhibit (Exhibition, 1876), labeled "Brown Kurrajong," by which name it is said to be known to the colonists. The name has been applied by other authorities to *C. platiphylla*. "The fiber of *C. echinata* is of a very tenacious nature, and is preferred to all others by the aborigines for making nets." The fiber is quite dark, and does not appear to be quite as strong as the first-named species in our list.

Dombeya Natalensis.—The plant is a native of Natal, and the specimens are from Victoria, collection of Dr. Guilfoyle (Exhibition, 1876). It forms a most beautiful flowering shrub or small tree, of quick growth in Victoria. Its fiber is suitable for cordage or for paper stock. The plant belongs to a genus of African shrubs, abounding in Madagascar and Mauritius, and extending as far north as Abyssinia. The bark of *D.*

platanifolia is used in Madagascar for the manufacture of ropes, twine, &c. The plants of this genus are cultivated in hot-houses for their beautiful flowers. Like all the species belonging to this family, the fiber is brownish in color, though lighter than "Kurrajong," and, judging from the museum samples, is a little stronger. It is at best, however, a very coarse fiber and is not to be compared with mallow fiber of the commonest description, neither is it as fibrous in texture as *Commersonia*. Possibly a better prepared specimen might show better qualities.

4.—TILIACEÆ.

In this family are included the well-known Linden trees, so much cultivated for adornment in public parks and gardens, *Tilia Americana* being the American representative, while *T. Europæa* abounds in Europe, and furnishes the bast for Russian mats. The most important fiber plant in the family, however, is the jute of India. The genera *Triumfetta*, *Sparmannia*, and *Muntingia* are also represented.

Tilia Europæa.—Lime, Linden.—The bast of this tree is much employed in Russia in the manufacture of an exceedingly coarse kind of rope for making the matted shoes worn by the peasantry, and also for the manufacture of the mats which are used to a considerable extent by furniture dealers for packing. They are also used by gardeners as a covering or protection to glass frames. For the larger and better kinds of mats, trees eight to sixteen years old are used, which are cut when full of sap, and the bark immediately separated from trunk and branches. It is then stretched upon the ground to dry, two or more strips being placed together. When required for use, simple soaking in water separates the cortical layers, the best of which are in the interior, and the coarsest being on the outside. As many as 14,000,000 pieces of matting have been produced in Russia alone in a single year, as these mats are a considerable article of export. Their manufacture is largely confined to Russia; Sweden, however, furnished a portion of mats exported. The Swedish fishermen use the inner fiber or bast for the manufacture of fishing-nets.

A Japanese species, *T. cordata*, is much esteemed in Japan for its fiber or bast, which is used for strings and ropes, and sometimes for making a very coarse cloth. An important branch of industry is the manufacture of mosquito nets, the bark of this specis being used for the purpose. The wood of the Linden tree is white and soft grained, and is used for carving, turning, and to some extent for the manufacture of furniture, both in this country and in Europe. In our own country it is known as basswood. In this connection it may be mentioned that many of the Sterculiaceæ would furnish a bast that would form an excellent substitute for the "Russian" in the manufacture of mats.

Corchorus capsularis, Corchorus olitorius.—Jute, Jew's Mallow.—This valuable fiber, which of late years is attracting so much attention in our own country, has been cultivated in India from a remote period, though the knowledge of it as an article of commerce dates back not a hundred years ago. Jute is the product of two very distinct plants, both of which are common in almost every part of India. The genus Corchorus includes six species of fiber-producing plants, as *capsularis*, *olitorius*, *fuscus*, *fascicularis*, *trilocularis*, and *decemangularis*. The principal point of difference between the two cultivated jute plants is in the seed-pod, that of *capsularis* being "short, globular, rough, and wrinkled," while that of *olitorius* "is elongated (about two inches), almost cylindrical, and of the thickness of a quill." The first-named species is generally cultivated in the central and eastern districts, where the other species are rare. Among

the many varieties of jute the most common are known by the names *Uttariya*, *Deswal*, *Desi*, *Deora*,* *Naraingunji*, *Bakrabadi*, *Bhatial*, &c., valued in the order in which they are named.

Jute doubtless takes its name from the Sanscrit, as the words *jhont*, *jhot*, and *jhat* are all derived from the Sanscrit *jhat*, meaning "to be entangled." One form of the root is *jat*, and from it are produced *jata* and *jute*, both meaning "matted hair." The name *jute* was first used by Dr. Roxburgh. The Bengal name of the plant is *Pat* or *Paat*, the fiber *jute*, the cloth *Tat Chotee*, and *Megila*. The Malays call the plant *Rami Tsjina*, and the Chinese name is *Oi-moa*, &c.

As to the geographical distribution of jute, *C. capsularis* is cultivated in India by the Malays and by the Chinese to a limited extent, and has been introduced into the United States.† *C. olitorius*, also cultivated in India, has been naturalized in all parts of the tropics ‡ as far north as the shores of the Mediterranean. It is also grown in Egypt and Syria as a pot-herb; hence the name, Jew's Mallow.

C. siliquosus is a species indigenous in the West Indies and other portions of tropical America. The negroes are said to use the twigs for making besoms, but it is not regarded as a fiber plant. The genus Corchorus includes, in all, some forty or fifty species of plants. When examined longitudinally with the microscope—

> The fiber has the appearance of compact and closely-united bundles. They are exceedingly difficult to separate, even after a strong alkaline bath. They can, however, be separated into cells which are short, stiff, and pointed. The body of the fiber seems to be bordered with two brilliant bands, which represent the thickness of the cell walls, which is ordinarily slight in comparison with the interior cavity. This character, though general, is not absolute. The surface of the fiber has a smooth appearance, though the profile is sometimes notched or marked with deep sinnosities, especially noticeable toward the ends, which grow slender in a more abrupt manner than the long fiber of flax and hemp. The central cavity is nearly always apparent, even to the extremity of the fibril.

Viewed transversely with a power of 300 diameters, the sections of the fibers are polygonal, with straight sides and sharp angles. In the center of each polygon there is a round or oval opening with smooth edges. The fibers are always shown to be gathered in compact masses, or often joined closely together. Some of the polygons are almost triangular in shape.

Experiments as to tenacity are recorded as follows: Common flax broke with a strain of 39 pounds; jute (*C. capsularis*), 67 pounds and (*C. olitorius*) 68 pounds; English hemp, 105 pounds; Agave fiber, 110 pounds; and India bow-string hemp, 120 pounds. These experiments place jute between flax and best English hemp for strength.

The collection of jute in the museum is an interesting one. A few specimens of American-grown jute fiber are exhibited, as showing the result of experiment in this country. The principal series, however, was presented to the department by the Methuen Jute Manufacturing Company (of Massachusetts) and illustrates the manufacture of the fiber in

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* It has been stated that "in the Deora districts of Furredpore and Backergunge the plant which thrives so well in the marshes is the *Deora jute*, which in reality is only the *Maesta* (*Hibiscus cannabinus*)."—*Report on Cultivation of Jute in Bengal.*

† The seed of jute has been repeatedly imported and distributed by the Department of Agriculture, and grown experimentally, with a fair degree of success, throughout the cotton States, but has failed to become a commercial product from the lack of perfected machinery for the economically successful preparation of the fiber. For details of jute culture in the United States, with the results of experiments, see annual and monthly reports from 1870 to 1875, inclusive, published by the department.

‡ Specimens of jute of both species accompanied the Queensland collection of fibers, presumably grown in that country, but, as it is not so stated in as many words, I will not say that jute has been introduced into Australia.

the United States, from foreign material, into a variety of coarse and fine fabrics. Gunny and baling stuff, sacking, burlaps, crash, carpeting, &c., are exhibited, together with a series of prepared fiber in various stages. The most beautiful manufactures from this textile, however, are a series of jute tapestry samples, used for ornamental purposes in upholstering. Some of these are of remarkable fineness, and are dyed in delicate colors. An example of the *finer* specimens, however, with the microscope, revealed the fact that cotton entered largely into their composition, particularly where very delicate patterns had been introduced. A finer quality of burlap—as regards finish—is now extensively manufactured, which, after filling with embroidery, is used for mats. This kind of "fancy work" is especially popular with the ladies at the present time.

Triumfetta semitriloba.—This fiber very closely resembles jute in color, strength, and general characteristics. The specimen was received from the Smithsonian Institution (1860), without data other than the name, so the locality cannot be given.

The plants of the genus are both numerous and widely distributed, abounding in tropical countries in many parts of the world. Fiber is obtained from both *T. semitriloba* and *T. angulata*, the first named found in both hemispheres, while the latter is indigenous to Asia, where it abounds in the tropics.

Sparmannia Africana.—Dr. Guilfoyle, who prepared this sample of fiber says that, "though a native of Africa, the plant is of quick growth in Victoria, and the fiber, which is produced in large quantities, is of a very fine texture. For many purposes it is equal, if not superior, to the Chinese grass-cloth plant."

The fiber is of a beautiful silvery-gray color when it has been properly prepared. Some of the filaments of this sample are brilliant and lustrous, and it possesses considerable strength; in fact, seems almost equal to China grass in tenacity.

There are four species of *Sparmannia*, all of which are African trees or shrubs, with heart-shaped, toothed, or lobed leaves, and bearing white flowers. *S. Africana* is to be met with in green-houses, "having been introduced by Captain Cook on his second voyage."

Muntingia calabura.—This tree abounds in the West Indies and South America, where its wood is valuable for many purposes, and especially for making staves. In Venezuela it is known as *Majaguillo*, and its fibrous bark is sometimes used for coarse ropes and cordage. Its bast is very soft and pliable, twists easily, and if used in this manner, without attempting to separate or clean the fibers, is possessed of ordinary strength. The fibrils are exceedingly fine and silky, so much so that the bast, when broken, exhibits at the point of rupture the flossy appearance always seen at the raw ends of skein or embroidery silk. Separating the fiber would undoubtedly diminish its strength. The specimen was received from Venezuela (Exhibition, 1876).

5.—LINACEÆ.

Linum usitatissimum.—Flax.—Flax has been employed as a textile from the earliest periods recorded in history. Fine linen is continually mentioned in the pages of Holy Writ, and Solomon imported flax from Egypt, which was woven into cloth by his subjects.

The first record of flax culture in this country shows that, in 1629, in the town of Salem, Mass., "an acre of ground was set apart to one Samuel Cornhill" for its cultivation. It was ordered to be introduced into the Colony of Massachusetts in 1629, and in 1640 the general court

of Connecticut ordered flax to be sown by each family in order to preserve the seed.

In modern times flax is widely cultivated throughout the northern hemisphere, extending from the tropics in India and Egypt to the northern part of Europe, and in our own country. It is a little remarkable, but flax has never been cultivated in Japan to any extent, and only grown for its seeds or for medicinal purposes, ramie, hemp, jute, and other fibers taking its place as a textile. The greatest quantity of flax is probably grown in Russia. In our own country flax has been produced largely, but in late years its cultivation, excepting as grown for seed, has declined, as jute has come more generally into favor, and has been utilized for bagging as well as for other purposes. A few of its native names may be mentioned briefly, as follows: Sanscrit name, *Atasi*; Hindoo, *Alsi*; Indian, *Atees*; Bengalese, *Mornee*; Persian, *Ulsee*; Malayan, *Bidjee rammee*; Japanese, *Ama*, or *Nunegoma*; Persian, *Kutan*; Russian, *Son*, &c.

Flax fibers, when separated by alkaline solutions, and afterward by grinding in a mortar, under a power of 300 diameters, "appear independent of each other, transparent, and of uniform diameter for a great length; they look like glass tubes, apparently thick, with a capillary canal of extreme fineness in the center. These fibers are sometimes so full the canal is not visible." If the filaments are bruised between the fingers, so as to form creases at different points, and then examined with a very high power, breaks or fissures will be observed parallel to the axis of the fibers, and indicate the fibrous texture of flax fiber. "The ends of flax fibers are long, fine, and pointed like needles."

A section of bark examined transversely is found to be composed almost entirely of fibers agglomerated into groups or bundles, the different groups only separated from each other by the prolongation of a medullary ray. The sections of fibers which compose these groups are polygonal with straight sides, and, generally, sharp angles, though they are sometimes blunt or rounded. The central cavity is often represented by a point and sometimes by a very short line. In fibers of the last form, however, the openings are larger.

The flax collection of the department is a fair one. The finest samples are of Russian, Irish, Flemish, and Belgian flax, belonging to the old collection of the department. Through the Exhibition in Philadelphia the museum received large acquisitions of this fiber from the various countries where flax is grown. The American series is only an average one. The various stages of manufacture from flax-straw to fabric are illustrated, and good samples have been presented from different portions of the country. The most interesting branch of this collection, however, is the group of samples received from the Hemp and Flax Commission, which was appointed by Congress in 1863.*

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* Twenty thousand dollars was appropriated for "investigations to test the practicability of cultivating and preparing flax or hemp as a substitute for cotton." The war had cut off supplies of cotton from the South, and the want of a substitute began to be seriously felt. A commission was organized by the Commissioner of Agriculture, Hon. Isaac Newton, consisting of three members, Hon. J. K. Moorhead, Dr. John A. Warder, and Charles Jackson, esq. A report was made early in 1865, after examination of machinery and processes of manufacture in different sections of the country in which progress of inventions and manufacturing skill was reported, and the opinion expressed that the preparation of flax-cotton was not sufficiently developed to justify a prediction of ultimate success. The culture of flax and hemp was considered in detail, and the history, structure, and uses of these and other fibers were presented. Feeling that all attainable practical results of the investigation had been accomplished, and that the possible supersedure of cotton by flax or other fiber would never be realized, the Commissioner disbanded the commission and returned to the treasury $9,500, the unexpended balance of appropriation.

In this collection are shown the results of experiments in cottonizing flax (as well as hemp) with samples of fiber illustrating processes, and fabrics manufactured from it. Among these may be mentioned "fibriela," or flax-cotton cloth, which is one-half pure cotton, calicoes and other fabrics.

6.—LEGUMINOSÆ.

Crotalaria juncea.—Sunn hemp.—Indian names, *Chin-pat* and *Chumese;* Sanscrit name, *Sana.* The fiber is known as Sunn, Taag, or Cankanee hemp, Indian hemp, Brown hemp, and Madras hemp.

But one specimen of this valuable fiber appears in the collection of the department, received from Australia through the Queensland Commission (Exhibition, 1876); it is quite inferior to the India fiber.

Sunn hemp is "probably one of the earliest of the distinctly named fibers, as we find, in the Hindoo 'Institutes of Menu,' that the sacrificial thread of the *Cshatriya*, or Rajpoot, is directed to be made of *Sana.*" The plant producing this fiber is a shrub growing from 8 to 12 feet high, with branching stem marked with longitudinal furrows. When cultivated it is sown quite close, at the beginning of the rainy season, in order that the plants may grow tall and thickly together—the natives say, the thicker the better, so as to prevent the air passing through it—80 to 100 pounds of seed being used to the acre, and some even sow a larger quantity. A rather elevated rich soil is required, clay soils being injurious to it. In some portions of India two kinds are cultivated, one sown in May and June, when the first showers fall, and the other in October, though in quality they are the same; "that sown in June is cut in August and September, and the other about April."

Two varieties are known by the names *Phool* and *Boggy*, the first of which is most esteemed. It grows three or four feet high, producing a strong, durable fiber, while the last named is much larger, but the fiber is darker colored. When planted in June, it is harrowed in and little further care is expended upon it, as it grows so rapidly that weeds are choked out. The plant flowers in August and is 5 to 8 feet high, and when a fine, soft quality of fiber is desired, it is pulled at this time. For producing stronger fiber, the plant is left until the seed has thoroughly ripened. In the Madras territories the mode of cultivation differs a little from the above, as the seed is sown in October or as late as November, at the close of the rainy season. One hundred and twenty pounds of seed are used, covered in by means of the common Hindoo harrow. The fiber is considered to be in its greatest perfection soon after the flowers drop and before the seed ripen, when it is pulled by the roots, half dried in the sun, tied in bundles, and finally placed in the water to steep. In portions of the Madras district it is cultivated as a second crop.

In the Lucknow district it is cut near the root when the plant begins to flower, "tied in large bundles, and immersed in water, the natives putting small weights upon it (generally mud), to prevent its being carried away. After remaining in water from four to eight days it is withdrawn, taken by handsful, beaten on a piece of wood or stone, and washed till quite clean and the cuticle and leaves entirely removed." The woody portion is separated by further beating and shaking when perfectly dry. At Commercolly the plants are pulled, tied in bundles, and are then left standing in water on their roots to the depth of several inches. This allows the fiber to obtain the right degree of firmness, without becoming parched and dried by the sun. Oversteeping causes the bark to separate very easily, but weakens the fiber. Dr. Roxburgh found "no ad-

vantage, but the reverse, by drying the plant after maceration, and before the bark is removed," which is the mode practiced in regard to flax and hemp. After the fiber has been separated it is thoroughly washed, by repeatedly squeezing and wringing the water out of it, after which it is hung upon lines. When dry the fiber is separated a little, or combed with the fingers, and then bundled for market.

When the plant first began to attract attention among Europeans it was believed the Hindoo method of treatment could be improved upon with favorable results, but much opposition was raised by the natives, who declined, strenuously, going out of the beaten track of their fathers. It was found to be a much more delicate plant than hemp, and consequently could not be prepared after the European methods, without a modification of the processes.

The fiber of Bengal is always whiter than that of Bombay, owing to more careful preparation. The amount of dressed fiber produced upon an acre varies from 300 to 1,000 pounds, and the cultivation is said to yield a tolerable profit, as the plant requires so little attention. The fiber loses about one-third its weight by the process of hackling and combing, by the removal of tow and short fiber, but its value is increased, and, consequently, commands a higher price when exported in this form. As high as 7,000 tons of dressed sunn hemp have been exported from India to various parts of the world, valued at nearly $400,000, the exports varying as the years are more or less favorable. Of this quantity, about four-fifths goes to Great Britain, half the remainder to France and North America, and the small surplus goes to Asiatic countries.

Examined microscopically, Vétillart states that "the fibers appear strongly united to each other by a transparent substance which becomes opaque in the creases formed by friction in separating the fiber." When the fibers are prepared in glycerine, their surface appears to be "striated parallel to the axis of the fiber, and often split in the same manner." They are irregular in size. At points where the fiber has been bent, fissures are sometimes observable, which indicate fibrous texture. The ends of the fibers are medium in size, and rounded like the end of a spatula blade." "They bear a great analogy to those of flax and hemp." Examined in cross-section, the fibers appear in compact groups, often assuming a crescent shape, being swollen or larger in the center; when separated from these groups the sections of fiber generally appear with their angles somewhat rounded, exhibiting numerous very fine concentric layers. They are enveloped in net-work, the central cavity sometimes diminished to a mere point in the cells, which are very full, though sometimes it takes a linear form, "or large and open, sometimes empty, and sometimes filled with a granular substance." The fiber is very rough, the epidermis adhering in many places; the color is a faded or dirty yellow.

As to tenacity, experiments made with fiber grown and prepared under the supervision of the agent of the East India Company gave a result which, when compared with the best Russian hemp, was in the proportion of four to six, sunn being the weaker. Royle states that while "some recent sunn broke with 170 pounds strain, when Russian hemp broke with 160 pounds, the former may not bear the same degree of twisting as the latter." In Dr. Wight's experiments with sunn, cotton-rope, hemp, and coir, they were found to stand a strain of 407, 346, 290, and 224 pounds, respectively. The fiber is used principally for ropes and cables, though in India it is manufactured into cordage, nets, sack-cloth, twine, and paper. The finely-dressed and most carefully-prepared fiber is made into canvas of great durability. In the exhibition of 1851, specimens

of great strength and compactness were sent from Trevancore, made of a fiber called *wuckoo nar*. It attracted considerable attention, as it was totally different from any other Indian fiber, but afterwards proved to be *Crotalaria juncea*, changed by locality and climate, combined with variation in the mode of preparation.

Crotalaria tenuifolia.—Jubbulpore hemp.—This plant, considered by some authors to be a variety of *C. juncea*, is said to be superior to Russian hemp (*Cannabis sativa*), breaking approximately at a strain of 95 pounds for the first named to 80 pounds for the latter. It is 4 or 5 feet in length, and resembles best Petersburg hemp, compared with which Royle considers it equal, if not superior. Although its cultivation is limited, it is regularly grown for its fiber, which is used for the same purposes as sunn.

Ten per cent. is lost in hackling, and the cost and quality varies according to the locality or season of the year in which it is grown. From a report of the agri-horticultural society of India, plants nine weeks from seed "had attained the height of 8½ feet *without branching*, an important point in a fiber-producing plant, and commenced flowering three months from sowing." *C. tenuifolia* is a native of Coramandel, and is a perennial plant. It grows to a height of 9 feet in the botanic gardens of Calcutta. It is generally grown upon side hills, and is far stronger than when cultivated in the plains below, the lower situations tending to produce plants of great height, but of weaker fiber; while soil and climate have much to do with with its superiority, it is also due to careful manipulation in its preparation.

Pterocarpus santalinus.—This is another leguminous plant from India, producing a rather inferior fiber. There are fifteen or more species in the genus, and all are plants of large size, scattered over tropical Asia, Africa, and America. The fiber is reddish in color, composed of quite fine filaments of moderate strength. From the size and appearance of this specimen, which is quite old, I judge it has only been extracted experimentally. A twisted cord of the fiber, about the size of common manila-paper twine, would show about the same tenacity. The plant yields a deep red dye, known to commerce as "Red Sanders," large quantities of which are exported from India annually. Gum kino is obtained from two species of *Pterocarpus*, one growing in India and the other in Africa. Some of the barks are also used for tanning. It would doubtless make a good paper-stock, if it could be cheaply extracted and in large quantities.

Sesbania aculeata.—The plants belonging to this genus of Leguminosæ are tropical annuals, found in many parts of the world. The species named gives the well-known *Dhunchee* of India, which is highly esteemed for the manufacture of ropes and cordage, and is regarded as a coarse substitute for hemp. The plant is a native of the Malabar coast, and also grows in China. In Bengal it is called *Jayunti*. The plant grows to a height of 6 to 10 feet; the fiber is long, but much coarser and harsher than hemp. Bengalese fisherman make the drag-ropes of their nets of this substance, on account of its strength and durability. It is generally grown in wet soil, requiring little preparation, as the plant is hardy and of rapid growth. It is sown at the rates of 30 pounds of seed to the acre. In Northwest India, during the rainy season, it springs up in rice-fields, and other wet, cultivated lands. A peculiarity of the fiber is its remarkable contractability, as from contraction alone ropes made of it are said to be able to carry away the mainmast of a ship. Royle publishes the statement of an Indian gentleman to the effect that "it is considered a much hardier plant than jute, and certainly very superior

in strength and durability." Tests of Dhunchee rope, with that of Jubbulpore hemp and pineapple fiber were as follows: A $3\frac{1}{2}$ inch (in circumference) untarred, 4-strand rope of Dunchee broke with a strain of 75 cwt., and $3\frac{1}{2}$ untarred, 4-strand rope of Jubbulpore broke with 83 cwt.; and a rope of pineapple fiber, same dimensions as the last, and same conditions, required a strain of 57 cwt. to snap it. Although Royle holds this plant in such high estimation, a recent authority, in the "report on the cultivation of jute in Bengal," it is stated that "it is of little value as a fiber-producing species." It is common in every part of India. Its sticks are extensively used in Bengal as props for vines and creepers in gardens, and also for fuel. "The fiber, as usually prepared, is coarse but strong, and is employed in the manufacture of cordage of an inferior quality. It is never used to adulterate jute." There is no specimen of this fiber in the museum, but as there is an allied species growing in this country, producing the Colorado River hemp, a description of the India fiber becomes interesting. The American representative is mentioned below.

Sesbania macrocarpa.—Samples of the canes or stems of this plant were sent to the Department of Agriculture several years ago from the Colorado River, and more recently specimens of a very coarse fiber have been received from Dr. E. W. Palmer, known as "Colorado River hemp," which, in all probability, is derived from this plant. Dr. Parry informed me that the plant is very abundant on the alluvial banks of the Colorado, and could be obtained in large quantities. It also grows in South Carolina, Arkansas, and Texas.

The fiber is 3 or 4 feet long, and the filaments are exceedingly coarse, and resemble flat ribbons of fiber, uncommonly white and lustrous, and clear and smooth to a remarkable degree. Single filaments are quite strong, but when several are twisted together lose a part of their strength; a defect sometimes observed in better fibers. It is somewhat elastic, but its smoothness and elasticity are not in its favor where tenacity is required, as the filaments will not *cling* when worked together, the strain coming upon individual fibers, first one and then another giving way, and the rope, therefore, weakened. As an evidence of this, I am enabled to draw out a filament two feet long from a little package of fibers folded five or six times and tied with a string without entangling in the least the fibers remaining in the package. It is sufficiently strong for small cordage for ordinary use, though too coarse for fish-line or twine. Compared with the fiber of *Apocynum* (our Indian hemp), or even with okra, it is a very indifferent fiber. It is prepared and used to some extent in the locality where grown, and is doubtless easily manipulated. The sticks or canes are very straight, and are about a third of an inch in diameter.

Bauhinia splendens.—The Chain Creeper.—These leguminous plants are extensively diffused throughout the tropics, and are found particularly in India and South America. They are generally climbing plants, attaining great size, though some are shrubs. Two large coils of rope made from bark of the Chain Creeper were received from Brazil and Venezuela (Exhibition, 1876). In the last-named country the tree is called *Bejuco de Cadena.* Dr. Ernst, of the Venezuelan commission, says the plant is common in the hot, damp forests. "The stems are extremely flexible and tough, so they can be used as cords, being more durable than iron nails, which in the damp atmosphere rust very soon and give way. The ribbon-like strip is very dark—almost black—and the cordage made from it is of the very coarsest description, the entire bark often,

as peeled from the tree, entering into its structure unbroken. The two cables are about an inch in diameter."

B. racemosa, known as the Maloo Climber, abounds in the valleys of the Himalayas. The bark, reddish in color, is very tough, and is used in India for very coarse cordage and ropes, and from their great strength have been employed in the construction of bridges across the Jumna River. The stems are usually cut in July or August, the outer bark being stripped off and thrown away, while the inner layers are used for rope as wanted, being previously soaked in water, and are twisted wet. *B. scandens*, another Indian species, was tested, and found to be of about the same tenacity as the best sunn (*Crotalaria juncea*). A line made of the fiber supported 168 pounds for forty-five minutes, having stretched six inches in about three feet.

7.—ONAGRACEÆ.

Epilobium.—Willow Herb.—Samples of Epilobium fiber were received from Utica, N. Y., by the Flax and Hemp Commission, as specimens of a fiber that might be used as a substitute for cotton for textile purposes. The species of Epilobium are mostly perennial herbaceous plants, from 2 to 7 feet high, bearing pod-like vessels which are filled with cottony seeds. The fiber is accompanied by home-made samples of "thread," rope, and a piece of quilting to illustrate the value of the fiber as a substitute for cotton batting. The fibers are not half the length of upland cotton, or not more than three-eighths of an inch, and consequently could not be spun; and even mixed with other fibers, would fly off in the process of manufacture; the fiber is soft, has a silky luster, and is of a creamy white color. Examined microscopically, the filaments consist, like most seed hairs, of single cells. Their walls are very thin, make sharp bends, and seem to be brittle, without the least wind or twist, and, while resembling the down of Asclepias, are of less length, with a rather strong longitudinal marking. The specimens are only interesting in the light of experiment, and from the fact of their having been presented by the Flax and Hemp Commission.

8.—MYRTACEÆ.

Eucalyptus obliqua.—The Stringy Bark.—But one species of the Myrtle family is represented in the collection. The specimen is a sample of tow, prepared by Dr. Guilfoyle, and forwarded with the Victorian collection (Exhibition, 1876). The fiber is reddish in color, of little strength, and has been prepared experimentally. No data accompanied the specimen regarding its value, either for fiber or for paper stock, though the aborigines of Australia are known to manufacture both canvas and cordage from the Eucalyptus, which would indicate not only strength but considerable fineness.

There are 100 to 150 species of trees belonging to the genus, for the most part confined to Australian and Tasmanian forests. Many of the trees are gigantic in size, and are exceedingly valuable for their timber. *E. globulus*, the Blue Gum, *E. gigantea*, the Stringy Bark, and *E. amygdalina*, the Peppermint tree, yields the best quality. Eucalyptus oil has attracted some attention in late years, particularly since the Exhibition, and *E. globulus* is well known through its having been recommended for planting in malarial districts. Fiber of *Eucalyptus fissilis* was also sent to the Philadelphia Exhibition, prepared by the director of the Melbourne Botanic Gardens, Victoria.

9.—CUCURBITACEÆ.

Luffa cylindrica.—Sponge Cucumber.—This is also called *Papinjay*, and is the *Estropajo* of the Venezuelans. The fruit is from 6 inches to 1 foot in length, the interior being formed of a dense tissue of wiry fibers and containing three longitudinal tubes, in which are found the numerous black seeds. It is also called "dish-cloth plant," as the dried fiber, after the removal of the outer integument, is used as a substitute for this indispensable article of household economy in the South, the fibers becoming soft and pliable in water. Although the species are natives of tropical Asia and Africa, the plants are found in many tropical and semi-tropical climes. Museum specimens have been received from South America, the West Indies, and the southern portions of the United States. Ornamental baskets are sometimes made from the sponge cucumber, and among the curious objects in the museum the visitor is shown a bonnet, worn in the South during the late war, made entirely of this fiber. To prepare it, the cucumbers were cut through lengthwise upon one side only, and opened out *flat*, the fibrous walls of the tubes before mentioned forming longitudinal ridges which appeared on the outside of the bonnet. Several cucumbers were required to make this dainty head-covering, which was sewn together and afterwards shaped with scissors, and lined on the inside and trimmed with pink cambric.

10.—APOCYNACEÆ.

Apocynum cannabinum.—Indian Hemp.—Indigenous in the United States. This is a species of perennial herb, belonging to the dogbane family, with upright branching stems four or five feet in length, having opposite leaves and a tough, reddish bark. As the name indicates, it is used as a substitute for hemp by the North American Indians, as the plant flourishes in many portions of the United States. A peculiarity of the plant is that "its stalks exude a milky juice, which when dried exhibits the properties of India rubber." Its fiber is utilized in the rude manufacture of bags, mats, small ornamental baskets, belts, rope, twine, fish-nets and fishing-lines, &c. It is easily separated from the stalk, and when cleaned is quite fine, long, and tenacious. In color it is a light cinnamon, as usually seen, though finely-prepared specimens are creamy white and remarkably fine and soft.

In the museum there are samples of the fiber from Minnesota, Nebraska, Utah, Nevada, and Arizona, together with a great variety of articles of Indian manufacture. The finest prepared specimen is a fish-line, such as is used by the Pi-Utes at the Walker River Reservation in Nevada. The fiber will rank with Asclepias for strength, and is readily obtained, as the stems are long, straight, smooth, and slender. Although paper has not been made of it, it could doubtless be utilized for the purpose.

Lyonsia reticulata.—A specimen of so-called fiber from the seed-vessels of this plant was received from the Queensland collection (Exhibition, 1876). It is worthless as a "fiber" and can only be classed with "silk cotton" from the *Bombax*, and with "vegetable silk" from pods of Asclepias. The plant is a creeper belonging to the dogbane family, having cucumber-shaped pods, which are the source of the fiber. The plant is a native of Australia.

11.—ASCLEPIADACEÆ.

Nearly allied to the dogbane family is the family of milk-weeds, many species of which are found in the United States, and nearly all possessed of a fibrous bark, their seed-pods filled with silky hairs.

Asclepias cornuti.—Milk-weed, Silk-weed.—Habitat, United States. This genus comprises a number of course herbaceous plants with a milky juice, which, for the most part, are natives of North America. The collection contains not only good specimens of the fiber from this country, but from South America. Among these are specimens of the "silk" obtained from the ripened pods, useless for textile purposes, yet attracting attention from its beauty. One sample in particular was sent from South America as "vegetable silk," with fabulous accounts of the beautiful fabrics that could be made from it.

The only portion of the plant of which practical use can be made is the bast, which furnishes quite a fine, long, glossy fiber, that is strong and durable. It ranks between flax and hemp, and in yield is about equal to the latter. Dr. Schaeffer made comparison of the two fibers in Kentucky, and the result was most favorable for that of Asclepias. He says:

> The native fiber was taken in winter from the decayed stalks, as they stood in the ground, where they grew without culture, while the hemp had not only been cultivated, but treated afterwards with the usual care. The fiber of the milk-weed was *nearly, if not quite, as strong* as that of the hemp, but apparently finer, and more glossy, while the quantity from a single stalk of each was nearly the same.

There are many species of silk-weed, the commonest of which, *A. cornuti* (*A. syriaca* of Linn), is found growing wild in many portions of the United States, but does not seem to have been utilized for fiber beyond limited experiment. The culture of the plant is said to be attended with little difficulty, as it generally thrives on poor soil. "As it is a perennial, with strong roots, successive crops might for a long time be obtained from one sowing of the seeds, or planting of the roots." Planted at suitable distances it could be easily cultivated, and, if close enough, would produce a heavy crop of long, slender stems clothed with abundance of fiber.

Among the specimens of the bast are several from Brazil, which have been finely prepared and show that the fiber is known in that country, though the writer can find no records of its manufacture. "An early knowledge of the fiber of silk-weed caused its introduction into Europe, where it has finally become a cultivated plant, while in its own country but little is known of its true value." Dr. Masters, an European authority, states that "its excellent fiber is woven into muslin, and in some parts of India is made into paper." From the Flax and Hemp Commission the department received small pieces of Asclepias cloth mixed with one-third cotton. This, though coarse, is quite strong. From the report of the Flax and Hemp Commission, page 74, the microscopic character of this sample of fiber is given as follows:

> Imperfectly cottonized, and of course unequal in staple. Some single cells, which could be drawn out, were found to resemble flax in many respects, but differing in decided markings that form long spirals, and also in the diameter of the internal cavity, which is less than that of flax, and more irregular. * * * A specimen from Russia shows that the cells will not average more than three-fourths of an inch, if so much.

The fiber forms a good paper material, and might be cultivated with profit for this purpose. The "silk" possibly might be employed as wadding, or for upholstering purposes—it has been used for stuffing

pillows in Canada; it is useless for any other purpose. However, there is a record of paper having been made from it in the last century. The cells are smooth and cylindrical, and will not felt or fasten themselves together, so can only be classed as "down" or silky hairs.

Forbes Royle states that—

The silk-like down of *Asclepias syriaca* is not more than an inch in length, but it has, nevertheless, been applied to articles of dress manufactured from it both in France and Russia. Representatives of the Asclepiadaceæ are found in Asia, in the north of Africa, the south of Europe, Siberia, North and South America, Japan, Cape of Good Hope, and New Holland. The bast fiber has been prepared, experimentally, in Russia, and directions for its preparation are given by German authorities.

Calotropis gigantea.—Giant Asclepias. Yercum.—This is an Asclepiadaceous plant of considerable value in Indian pharmacy, growing wild upon arid wastes, and producing a fiber of superior quality that might be used for many purposes. It resembles flax somewhat in appearance, and is quite strong. It is not cultivated in India, though its fiber is regarded in Madras, where the plant grows wild, as the best and strongest material for bow-strings and tiger-traps. The plant is known under a variety of names, as *Ashur* in Arabic; *Muddar* and *Ak-Muddar* in Hindoo; in Madras it goes by the name of *Yercum*.

The mode of separating the fiber, as practiced by the natives, is exceedingly tedious, and would prevent the material from becoming an article of commerce unless some more speedy and less trifling way for preparing it could be discovered. In short, no water is used, and everything is done by hand manipulation, assisted by the *teeth*. Flax machinery might facilitate the matter if it was desired to cultivate extensively for fiber. The pods also contain a silky down, which in Madras is used for the manufacture of a soft, cotton-like thread. As to its cultivation, "it is difficult to conceive anything less productive than dry sand, yet the Muddar thrives in it, requiring no culture and no water." Dr. Wight tested samples of the fiber from Madras, where it is much employed for fish-lines, and found that it bore a strain of 552 pounds, when Sunn hemp bore 404 pounds. Royle's experiments gave 160 for Russian hemp and 190 pounds each for Jubbulpore hemp (*Crotalaria*) and the Muddar or *Calotropis gigantea*. A soft kind of cloth has been made from the silky down of this tree by mixing with cotton. It has also been used in the manufacture of paper.

Marsdenia tenacissima.—Rajmahl Bowstring Creeper.—This plant produces the *jeetee* fiber of India. There is no sample of the fiber in the museum, but as it is often referred to, and is a well-known fiber, it will be proper to include it in our list. The plant grows in the Rajmahl hills of India in dry and barren places, and the fibers of the bark are employed for making bowstrings by the mountaineers. "The fibers are not only beautiful in appearance, but strong and durable."

In Dr. Roxburg's tests of twine made from *jeetee*, he found that in the dry and wet states it bore a strain of 248 and 343 pounds, when hemp in the same states bore 158 and 190 pounds. More recent tests, however, place it below hemp in strength, but above it in elasticity. The fiber is much used for making nets, and is not liable to injury by being kept in water.

Orthanthera viminea, another plant belonging to the milk-weed family, grows near the foot of the Himalayan Mountains, its long, slender, leafless, wand-like stems, 10 feet or more in length, furnishing a fiber of remarkable tenacity, suitable for rope-making. Other plants of this family in different parts of the world are mentioned as producing fiber; they are, however, of minor importance.

12.—CORDIACEÆ.

Cordia macrophylla, *Cordia sebastina*, *Cordia gerascanthus*.—Small samples of fiber from these three species of cordiaceous plants were received from the Smithsonian Institution (1869), without locality or other data than name. The plants of this genus, numbering 200 or more species, are found in various tropical and sub-tropical regions of the world. They are trees and shrubs, and have been valued for their medical qualities, and for timber, more than for fiber, which is known as *Naravali*. In Mysore, *Cordia angustifolia*, called by the natives *Narnuli*,* is used in the manufacture of rope. The bark is extracted in ribbon-like layers, and then twisted into cordage. It is possible some of the species might yield a useful fiber for textile purposes, though the examples in the museum are very inferior. In its lace-bark appearance the bast resembles *Sterculia*; it is white in color, soft, and of inferior tenacity.

13.—THYMALACEÆ.

Lagetta lintearia.—Lace-bark of the West Indies.—There is quite a pretty and interesting series of lace-barks in the museum, the most beautiful of which is the species named above. It is remarkable for the net-like appearance of its easily-separated layers of bark, and when detached and slightly pulled apart, so that the fibers shall not be parallel, exhibits a beautiful natural lace of creamy whiteness and "soft finish." There are a number of examples, the most interesting of which is a section of the tree itself, about a foot in length, enveloped in its natural bark at one end, while at the other the layers of inner bark are pulled apart and frayed to exhibit the lace, which is seen in concentric layers, the fibers interweaving in every direction. The specimens are from Jamaica, where the tree goes by the name *Lagetto*. It is said that the governor of Jamaica presented to Charles II a cravat, frill, and pair of ruffles made from this material. On the island it is made into very beautiful articles of wearing apparel, such as collars, bonnets, &c.; and even the museum specimens have been coveted by lady visitors as trimming for hats. I have never heard of the fiber being used regularly for cordage, though it is sold in long strips in the public streets of some of the cities of Brazil. It has sometimes been made into thongs, with which to whip negroes.

Daphne tenuifolia.—Somewhat similar to the above are the plants of the genus Daphne, which are widely distributed throughout the globe, in both temperate and tropical climates. There are a number of fine examples in the museum, from Brazil, and other localities, and among them one specimen of *D. cannabina* (Smithsonian Institution, 1869). Their principal use is in the manufacture of paper of varying quality, the best of which has the recommendation of being strong and tough, and not liable to crack or tear, when creased and folded, and not liable to be affected by dampness. In India, its durability renders it valuable for deeds and records.

In Nepal the bark of *D. cannabina*, and *D. Edgworthii* is thus employed. For this purpose it is scraped and boiled in water with a small quantity of oak-ashes; after this it is washed and beaten to a pulp on a stone, and then spread out on a mould or frame of bamboo matting. Some of the museum specimens are beaten out into a

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* These two names are doubtless the same, the orthography having accidentally been changed. It is worthy of remark that the differences in the spelling of Indian names by various authorities may be due to their having written the names as they seemed to be pronounced by the natives. "Jeetee" and "Chittee" are examples.

coarse kind of *Tapa* cloth, and are used in this way, doubtless, for clothing. The fibers of Daphne, under the microscope and when examined in glycerine, appear united in bundles; they are easily separated by the needles. They are very fine, stiff, and generally full, and their surface appears smooth without longitudinal or transverse striæ. The body of the fiber shows a swelling at the points where it has been suddenly folded upon itself. The most of the cells have a comparatively regular and uniform diameter, but we meet with some in which the middle is very large for a little distance, the fiber then becomes suddenly thin and at each end terminates in fine long points; they are usually rounded at the end and sometimes exhibit a tendency to bifurcate. The part widened in the middle contains a large cavity which is very apparent.

Pimelia axiflora.—Similar to the plants of the Daphne group are those belonging to the genus Pimelia, which are natives of Australia, Tasmania, and New Zealand, comprising some seventy or more—slender branching shrubs bearing white or yellow flowers. The species have all, more or less, tough, stringy bark, suitable for textile purposes. Dr. Guilfoyle prepared the present species, and accompanies it with this description: "The Curryjong of the aborigines, a tall glabrous shrub with smooth bark of exceeding toughness, suitable for fishing-lines, whip-cord, &c. It is found plentifully in the forests and gullies in alpine and sub-alpine situations." Samples of Curryjong paper are also exhibited in the collection of paper substances received at the same time.

The seeds of the plant yield an oil from which the genus—derived from the Greek *pimele*, a fat—received its name. Some of the species are cultivated as greenhouse plants.

14.—URTICACEÆ.

Boehmeria nivea.—Ramie, China Grass.—This is another plant of practical value to American agriculture, though its value can hardly be said to be appreciated save by the few who have fought over the ground of experiment. As to nomenclature, we have adopted the Javanese name of the plant, which is known as *Ramee.* In India it is commonly known as *Rhea*, having been cultivated from time immemorial in Assam, Dinglepore, and Sylhet, where it is regarded as most useful for fishing-nets. The cultivated variety, though botanically the same as the wild, is called *Dome rhea*, and is produced for nets and fishing-tackle, while the latter variety is called *Ban rhea.* With the Singpoos the name is *Pan*, and cloth is made from it, while in Burmah it is used to make a kind of linen. In Sumatra it is called *Calœe*, and the Chinese name is *Chu ma*, from which the celebrated grass cloth is made, and from which we derive our English name, "China Grass." Several varieties of Boehmeria are cultivated in Japan, and the process of preparing the fiber is similar to that in use for the preparation of hemp—as, indeed, all of their best fibers. The China Grass industry in Japan dates back to 1660 A. D., and the finest fabrics are manufactured at Yechigo (to the north of Tokio, on the west coast). The annual production amounts to nearly 100,000 pieces of goods, 9 to 10 yards in length.

In our own country ramie, as yet, has only been produced experimentally. That it can be produced in any quantity in the South is a settled fact, and that it can be grown successfully even as far north as New Jersey has been demonstrated within the last two years. Much has been written upon the subject of ramie culture, both in this and other lands, and no small share of ramie literature is to be found between the covers of department publications.

The strength of this fiber, judging from Dr. Roxburgh's experiments, places it in the first rank. He found that *Jeetee* fiber (*Marsdenia tenacessima*) broke with a strain of 248 pounds, when *Calœe* (or ramie) broke

with 240 pounds. Chinese jute was broken at 164 pounds, while hemp (*Cannabis sativa*) only stood a strain of 158 pounds. A recent experiment quoted in an India report shows a still greater difference between this and other fibers, a spun thread of Russian hemp having broken with a strain of 84 pounds, while a similar one of ramie only broke with the remarkable strain of 252 pounds, or in the proportion exactly of one to three.

The first museum samples were received about twelve years ago, from James Wade & Sons, England, and are interesting as showing the various stages or processes of manufacture, as well as the many beautiful fabrics that can be made from its fiber. The raw product in this series is India ramie, as imported, and this is followed by the dressed and bleached fiber, some of the specimens of silvery whiteness, and remarkable for brilliancy and luster. Then follows a large series of manufactures, principally poplin and mozambique dress goods, figured orleans, &c., in infinite variety. These are made of pure ramie, of ramie mixed with cotton, and, in some cases, ramie, cotton, and wool. Later, another series was received from the same manufacturers exhibiting a still greater variety of dress goods of various kinds, some of these having the luster of silk.

Many specimens of experimentally prepared fiber have been received from the South, together with manufactures, the results of experiments by Le Franc, Roezl, Bonzam, and others. In these manufactures of American ramie there are several specimens of fabrics suitable for handkerchiefs, shirt-bosoms, and the uses for which linen is usually employed. One interesting specimen of fiber (some two or three feet in length) exhibits the stalk as grown, the bark separated into fiber, and the cleaned ramie, all in one piece. There are also samples of finely-prepared fiber from other foreign localities than those mentioned, and one of these exhibits American ramie prepared in France. Some good specimens of rope are also shown, though, doubtless, this use of the fiber need not be encouraged while there are so many coarser fibers better suited to the purpose. Paper is also made from this substance, which is white and fine.

The Japanese series of China grass exhibits the state of perfection to which this industry has been brought in that country. It includes raw material variously prepared, together with textiles of great beauty. They are woven pure or mixed with silk, cotton, or other fiber, and some of them dyed in colors. For best modes of cultivation, preparation, &c., the reader is referred to Part Second of this report, where the latest facts regarding it are presented.

Urtica gigas.—Tree Nettle of Australia.—This is also called the gigantic nettle tree, and by the natives, *goo-mao-mah*. It is a native of New South Wales, and is very abundant on the McLeay and other northern rivers. In Bennett's "Wanderings of a Naturalist in Australia," the author states that the tree, when in full vigor, rises from its base by a series of buttresses of singularly regular outline, gradually tapering without a branch, to the height of 120 to 140 feet; the trunk then divides into a regularly formed, wide-spreading head, which excites admiration by its extraordinary size. The ordinary elevation of the tree is 25 to 50 feet. "The poisonous fluid secreted from the foliage is very powerful, particularly in the younger leaves, and their sting is exceedingly virulent, producing great suffering." The tree is also indigenous in Queensland, and Dr. Guilfoyle sends specimens of fiber from Victoria. The fiber is very strong and fine, and suitable for fishing-lines, &c. In New South Wales the fiber is made into cordage of considerable te-

nacity. The specimens were accompanied by a dilly-bag, made by an Australian aboriginal. The wood of this tree is soft and fibrous, and might be pulped up for fiber. It is claimed that the best and strongest fiber is obtained from the bark of the roots. The fiber is easily prepared and can be obtained in quantity.

15.—MORACEÆ.

Broussonetia papyrifera.—The Paper Mulberry.—This interesting and well-known plant is a native of the islands of the Southern Ocean, as well as China and Japan, but has been introduced into many other countries, and is now a common tree in gardens. In Japan, where it is highly esteemed for its fibrous qualities, it is known as the *Kodzu;* in China it is called *Tchou* and *Hoa-ko-chu.* Kendang is the Javanese name for the plant, while in the Fiji Islands it is known as *Ma-lo.*

In Tahiti and other South Pacific islands a species of cloth is manufactured from its bark known as *Tappa*, *Tapa*, or *Kapa*, an interesting series of which are shown in the department collection.

It is said that the finest and whitest cloth and mantles worn by Sandwich Islanders and "the principal people of Otaheite," are made from the bark of this tree. It dyes readily, particularly in red, and takes a good color. Tapa cloth is also printed; a large sheet from the Fiji Islands, in possession of the department, being stamped or rudely printed in black, in large checks or squares resembling the patch-work comfortable. The manner in which the fiber is beaten out by the native women of Otaheite is very curious. The cleansed fibers are spread out on plantain leaves to the length of about 11 or 12 yards: these are placed on a regular and even surface of about a foot in breadth. Two or three layers are thus placed one upon another, much attention being paid to making the cloth of uniform thickness; if thinner in one place than another a thicker piece is laid over this place, when the next layer is laid down. The cloth is left to dry during the night, and, a part of the moisture being evaporated, the several layers are found to adhere together so that the whole mass may be lifted from the ground in one piece. It is then laid on a long smooth plank of wood prepared for the purpose, and beaten with a wooden instrument about a foot long and three inches square. Each of the four sides has longitudinal grooves of different degrees of fineness, the depth and width of those on one side being sufficient to receive a small pack-thread, the other sides being finer in a regular gradation, so that the grooves of the last would scarcely admit anything coarser than sewing-silk. A long handle is attached, and the cloth is first beaten with its coarsest side, and spreads very fast under the strokes; it is then beaten with the other sides successively, and is then considered fit for use. Sometimes, however, it is made still thinner by beating it, after it has been several times doubled, with the finest side of the mallet, and it can thus be attenuated until it becomes as fine as muslin. Should the cloth break under this process, it is easily repaired by laying on a piece of bark, which is made to adhere by means of a glutinous substance made from the arrow-root, and this is done with such nicety that the break can hardly be detected. In other islands the bark is kept wet and scraped with sharp-edged shells. It is said the King of the Friendly Islands had a piece made which was 120 feet wide and 2 miles long.

In Japan, it may be mentioned as a peculiarity that a kind of cloth is made from paper derived from this tree. It is cut into thin strips, which are twisted together and spooled, to be used in the woof of the

fabric, while the warp is composed of silk or hemp. About 250 pieces only are manufactured at the principal manufacturing place. The paper-mulberry grows everywhere in Japan, and is a valuable tree as furnishing the bast from which a large portion of the Japanese paper is made. The plants are reproduced in quantity by subdividing the roots, and in two or three years are ready to be cut. This work is done in November, and the branches (7 to 10 feet long) are made up into bundles 3 or 4 feet in length, and steamed, so that the bark is loosened and can be more readily stripped off. This is washed, dried, and then again soaked in water and scraped with a knife to remove the outer skin, which is used for inferior kinds of paper. The bast when cleaned is washed, repeatedly kneaded in clean water, and rinsed. It is then bleached in the sun until sufficiently white, after which it is boiled in a lye, chiefly of buckwheat ashes, to remove all gummy matters. The fibers are now readily separated, and are transformed into pulp by beating with wooden mallets. The pulp is mixed in vats with the necessary quantity of water, to which is added a milky substance prepared from rice-flour, and the gummy infusion of the bark of *Hydrangea paniculata*, or the root of *Hibiscus manihot*. The couches on which the paper sheets are produced are made of bamboo, split into very thin sticks, and united in parallel lines by silk or hemp threads, so as to form a kind of mat. This is laid upon a wooden frame and the apparatus dipped into the vat, raised, and shaken so as to spread the pulp evenly, after which the cover is first removed, then the bamboo couch with the sheet of paper, and in returning the operative lays the sheet upon the others. When a number of sheets have thus been prepared they are pressed to exclude the water, and afterwards spread out with a brush upon boards and allowed to dry. The sheets are only about 2 feet in length, but sometimes sheets 10 feet long are produced.*

An effort was made in Europe to employ the paper-mulberry in the manufacture of paper, but these efforts have resulted in nothing, and the *broussonetia* remains an ornamental tree, and no one dreams of utilizing it in this industry.

Vètillart says the fibers of this plant, when separated (by boiling in an alkaline solution and afterwards ground in a mortar), "appear perfectly transparent, are striated longitudinally, and are often flattened on each other, and convoluted like a ribbon; the points are fringed and terminate in a round end. They have a tendency to crisp and curl up into rings, which indicates that they can be readily felted." As to size, those bordering on the epidermis are larger than the fibers in the parenchyma which border on the zone of the *cambium* (*Ficus* species not identified).

In Bernardin's Catalogue, before mentioned, there are no less than nine species of this genus represented as fiber-producing plants. Celebrated for one of its species yielding the fig, and another the caoutchouc of Assam, the genus *Ficus* abounds in Southern Europe, Africa, the warm parts of India, and the isles of the Southern Ocean, and representatives are found in the Western hemisphere. Royle alludes to the genus and says "it is probable that the bark of some of the species, like that of the paper-mulberry, may be converted into half-stuff, as the bark of one species is used for paper-making in the island of Ceylon."

In the collection of Brazilian fibers (Exhibition, 1876), there is one specimen that closely resembles the fiber of *Broussonetia papyrifera*, which was obtained from a specimen of "wild fig" found growing on

* This account is condensed from a report by the Japanese Commissioners to the Philadelphia Exhibition, 1876.

the Doce River, the milk of which is said to contain India rubber. Dr. Nicolau J. Moreira, reporting on fibers from Minas Geraes, in a little brochure of 16 pages, thus writes of the plant producing these specimens:

The trunk leaves, or stalk leaves (*i. e.*, layers?), although they cannot be separated into distinct fibers, nevertheless offer an interest not less industrial. By soaking, the leaves come out whole; when introduced between iron cylinders, in consequence of the compression suffered, they become very thin, yet preserving a remarkable width and length. In this condition, to say nothing of their being objects of curiosity, it is possible to transform them into thick garments for country laborers or other workmen. * * * Without further preparation, letters and official documents are written on the precious bark of this *rich* tree of the Doce River. M. Leverino Costa Leite has taken from one tree 275 cavados (206 yards) of bark sheets, three-fourths of a yard wide.

These samples are in the possession of the museum.

16.—CANABINACEÆ.

Cannabis sativa.—Hemp.—In our rambles among the fiber-producing plants of many lands, in the pages of this article we cannot fail to notice how often the word *hemp* is used and applied to so many different fibers.

However, we are considering now the true hemp-plant, which grows not only in our own country, but in many other portions of the civilized world, the fiber of which is so generally employed for rope that "stretching hemp" can have but one meaning. In fact, it has been so universally employed in the manufacture of cordage that the value of all other fibers, as to strength and durability, is estimated by it. In many of the experiments of Roxburgh and others we find "Russian hemp" (Petersburg hemp) or "best English hemp" taken as standards of comparison.

Its native home is India and Persia, although it is in general cultivation in many parts of the world, both in temperate and more tropical climes, though only in large quantities for export in Russia and Poland. French hemp is much valued, as well as that produced in England and Ireland; but the finest quality comes from Italy, and is pronounced fine, soft, light-colored, and strong. Hemp grows in all parts of India, and in many districts flourishes in a wild state. It is but little cultivated for its fiber, although Bombay-grown hemp "was proved to be superior to the Russian." In portions of India, as well as other hot countries, it is cultivated for its narcotic products, the great value of which makes the India cultivators indifferent about the fiber.* Hemp is largely grown in Japan for the manufacture of cloth. This industry is very old, as prior to the introduction of silk-weaving it was the only textile fabric of the country.

As the processes of hackling, &c., are not applied in Japan, the manipulation of spinning is rather tedious, all the fibers having to be taken off one by one and the ends knotted together so as to form a thread of sufficient length to be spooled and used for weaving. The province of Yamato is the principal center of manufacture of hemp fabrics, Nara, the capital, alone producing 400,000 pieces 9 to 10 yards in length. The Japanese method of cleaning and preparing hemp is to soak the stems in water, after which the bark is stripped off, and, if necessary,

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* When it is grown for the resinous principle which forms the intoxicating drug called *chang* (Hasheesh), the plants are placed some distance apart, so that the air and sun can get to them; while for producing fiber the opposite treatment is required, and the seed is sown thickly in order to force the stems to grow straight and tall without branching.

cleaned with an iron tool. The inner fibers are then washed and bleached, and brought to market in this state. This is a medium quality. The finest quality, and the whitest, is produced by steaming the stems, soaking for one day in water, and then stripping. A third grade is stripped immediately from the stem, and preserves a greenish color. In this connection it is interesting to note that wool has never been produced in Japan, and, as has been shown, cotton only dates back to the sixteenth century.

The Sanscrit name of the plant is *Bhanga*; in Hindostan it is called *Ganja*; the Arab name is *Kinnub*, from which, doubtless, its Latin name, *Cannabis*, is derived; in Persia it is known as *Bung*, while in China it is *Chu ts-ao*, and Japan, *Assa*. A dozen other names might be given, but the present will serve to identify it.

The plant is so well known in this country, and the mode of cultivation and preparation of the fiber such a familiar matter to those interested in producing it, that description seems unnecessary. Interesting facts, however, connected with the hemp industry will be found in part second of this report. The museum series of specimens, through the donations of the commissioners of the various countries represented at the Centennial, is quite full and complete, in fact more so in the foreign department than in our home series. It was noticeable, in preparing our own museum exhibit to send to Philadelphia, that the hemp industry in this country had declined materially from the meager response to calls for specimens. The cause of this decline, the remedy, and the future prospects of hemp cultivation in this country are given in another portion of this report. Among the specimens in the museum, the samples presented by the Flax and Hemp Commission are preserved, and form an interesting study. There are no specimens of hemp manufacture in the collection.

17.—MUSACEÆ.

We have been considering thus far the exogenous plants, the fiber of which is produced in the bark, and which, as we have seen, includes all our finer textiles, as cotton, ramie, flax, jute, &c. We now come to consider the class of endogens, furnishing what is generally termed foliaceous fiber, which is much coarser than fibers of the first class, and used principally for cordage, as the Manila hemp, New Zealand flax, pineapple fiber, &c. The first family is that of the plantain and banana, to which the Manila hemp belongs.

Musa textilis.—Wild Plantain.—This plant, as well as the fiber produced from it, the celebrated Manila hemp, is called *Abaca* by the natives of the Phillippine Isles. Other names are, however, given to the different qualities of the fiber, as *bandala*, which appears to be the harder and stronger outer fiber, which is used for cordage. The finer fibers of the inner layer are called *lupis*, and are employed in weaving delicate fabrics, while the intermediate layers furnish the *Agpot*, which enters into the manufacture of the web-cloths and gauzes. The natives distinguish the several varieties of the plant as follows: *Abaca brava*, or the wild *Abaca*, called by the Bisayas *Agutaï*; the mountain *Abaca*, which is used for making ropes, called *Agotag* and *Amoquid*; the *Sagay* of the Bisayas; the *Laquis* of the Bicoles, by whom the fibers of the original Abaca are called *Lamot*. The Malay name is *Pissang utan*.

The species of *Musa*, among which are the plantain and banana, are tropical plants, found in many portions of the globe. They are indigenous in the Phillippine Isles and the islands of the Indian Archipelago.

They have been cultivated from the most remote times, in tropical climates, in subtropical Asia, America, and Africa, and the islands of the Atlantic and Pacific Oceans, for the sake of the fruits. In the Phillippine Isles, where it is most used for its fiber, the plant is found in both a wild and cultivated state. The natural groves, however, are considered property.

The *Abaca* is cut when about one year and a half old, just before its flowering or fructification is likely to appear. If cut earlier, the fibers are said to be shorter but finer. It is cut near the roots, and the leaves cut off just below their expansion. It is then slit open longitudinally, and the central peduncle separated from the sheathing layers of fibers, which in short are the petioles of the leaves.

The fibrous coats, when stripped off, are left for a day or two in the shade to dry, and are then divided lengthwise into strips three inches wide. They are then scraped with an instrument made of bamboo, until only the fibers remain. When sufficiently scraped, the bundles of fibers may be shaken into separate threads, after which they are sometimes washed, then dried and picked, the finest being separated by women with great dexterity.

After the fiber has been cleaned in this manner, it is ready for the manufacture of cordage, and for all purposes where a coarse fiber is employed. The fine fiber, however, which is to be used for weaving, undergoes the still further operation of beating, which is performed with a wooden mallet, which renders the fiber soft and pliable, it having first been made up into bundles. The separate filaments are then fastened together at their ends by gumming; it is wound into balls, and is then ready for the loom. Sometimes it is dressed like flax, on a kind of hackle, and afterwards washed many times in running water until perfectly free from all extraneous matter, after which it is hung over poles or ropes to dry.

M. Perrouttel, a French botanist, in the "*Annales Maratimes et Coloniales du France*," states that the *Abaca* of the Phillippines differs essentially from all the varieties of banana known. Its stem is 15 to 20 feet high, of a dark green color, and very smooth on its surface. Its leaves are of the same color, long, straight, with strongly marked nerves. The fruit is small and triangular, resembling abortive bananas, and scattered here and there near the extremity of the fruit-stem. The plant requires a rich humid soil, and flourishes in thick forests at the base of the mountains, where it acquires in a short time an extraordinary development. In regard to the capability of the *Abaca* for the manufacture of fine fabrics, the writer says:

Of the finer sort tissues or muslins are made of great beauty, which are very dear, even in Manila. I had a number of shirts made from the muslin, which lasted me a very long time, and were cool and agreeable in the use. But it is especially in France that tissues of this material are best made and of the greatest beauty. They receive all colors with equal perfection. Veils, crapes, neckerchiefs, robes, and women's hats —all of great beauty and high cost, as well as of wonderful durability—are among the manufactures from the fibers of *Abaca*. Besides these are various articles of men's wear, such as shirts, vests, pantaloons, &c.

Another author mentions that beautiful shawls are made from it.

In the monthly report of this department for 1872, page 365, there is a communication on this subject by a resident of the Phillippine Isles, from which it will be seen that as late as 1872 no other method of extracting the fiber than the laborious scraping, described above, has been devised. Two men will cut and scrape about 25 pounds of the fiber in a day, the man that cuts the trees transporting them, stripping the layers, and cleaning the scraped fiber, though it is thought this is above

the average. "From 150 to 200 trees are required to produce one picul, or 140 pounds of fiber, or 3,200 trees for a ton of 2,240 pounds." Thus an Indian prepares only about 12 pounds of fiber per day. for which he receives his half share, 18 cents, which is the value of 6 pounds of the hemp, "yet this insignificant pittance suffices for the wants of himself and family."

In this connection it is surprising, when so many hundred thousand bales of fiber are produced annually, and the scraping is comparatively such a simple matter in itself, that machines have not long ago been invented to meet the wants or requirements of the natives and those engaged in the hemp industry. There are no slaves on the islands, and the natives work on shares or are small proprietors. In regard to *Abaca* culture in our own country, the writer last quoted states:

If specimens of Manila plantain were imported and propagated, it might be a source of great profit in the Southern States. No species of Musa examined in the South or in South America produces the Manila fiber. The plantains on this continent are too watery to allow the formation of useful fiber in the trunk.

The writer, I think, is mistaken in stating that the *Abaca* would flourish in the "Southern States." It might succeed in Florida. (See Plantain, or *Musa paradisiaca*, below.)

The fiber is white and lustrous, easily separated, stiff and very tenacious, and also very light, which is a great advantage when the fiber is used for the rigging and running ropes of ships. Viewed microscopically the bundles of fibers are very large, but are readily separated into smooth fibers of even diameter, after the alkaline bath. The central cavity is large and very apparent, the walls being of uniform thickness. The ends grow slender gradually and regularly. The detached sections (cross-sections) appear irregularly round or oval in shape, and the central cavity is very open and prominent.

As to tenacity, compared with English hemp, it stands as follows: A rope of Manila 3¼ inches in circumference and 2 fathoms long stood a strain of 4,669 pounds before giving way, while a similar rope of English hemp broke with 3,885 pounds. A second test of rope 1¾ inches in circumference, and the same length, gave 1,490 pounds for the Manila, and 1,184 pounds for the English hemp.

A large and valuable collection of *Abaca* or Manila hemp was received at Philadelphia (Exhibition, 1876), comprising a large portion of the fiber exhibit of the Philippine Isles. The fiber is exhibited in different stages, as well as samples of *Abaca* cloth and the manufactures from it. Other samples were received from the Queensland exhibit, prepared by Alexander McPherson.

The manufacture of Manila hemp in this country is for the most part confined to heavy cordage. Mr. Joseph Chisholm, a veteran manufacturer of Salem, Mass., states that Manila hemp began to be used extensively in this country, in Salem and Boston, in 1824 to 1827. In 1820 a sample was brought to the first-mentioned city by John White, a lieutenant in the United States Navy, on the brig Elizabeth. He also says:

In regard to the grass hemps, Manila hemp is stronger and more flexible (suant, some say) than any other growth. Tampico is more nearly allied to it, but is harsh. Sisal is not so strong as Manila; is of less length and harsher. Manila hemp as a growth remains to be rivaled upon this continent.

This fiber is imported in bales of 270 pounds, costing at present (January, 1880) 7¼ cents per pound. One New York manufactory used in 1879 41,366,710 pounds of this fiber, equivalent to 153,173 bales.

American-manufactured Manila for the most part goes into the rigging of vessels, or is used on shipboard, though it also finds use for every

purpose for which rope is employed. A considerable amount of cordage is exported.

Musa paradisiaca, *Musa sapientum*.—The edible Plantain and Banana.—These plants, like the Manila plantain, abound in fiber, coarse and strong in the outer and fine and silky in the inner layers, and much of it is well adapted for cordage. Royle, in regarding the first-named species, says there is no doubt that the large cultivated plaintain of India contains a considerable quantity of strong fiber, in the same way "that the yellow plantain does in Jamaica," and it seems worthy of inquiry whether the wild and useless plaintain growing at the foot of the Himalayas "may not *yield a stronger fiber than any of the cultivated kinds*." If the plantain is considered such a superior fiber-producing plant in the Old World, why should it not be equally as valuable in tropical America? It is grown in the West Indies,* or, rather, fiber in quantity is prepared from it.

The extraction of plantain fiber is accomplished in two ways, the first by machine-crushing and the second by fermentation. The tree is cut by a single stroke of a hatchet or cutlass, six inches above the surface of the ground; the tree is then divided longitudinally into four parts and the heart taken out, which is always left for manure. One man can cut and split 800 trees in a day. If fermentation is decided upon, the trees are left upon the ground until the juice and sap are separated from the fiber, when considerable weight will have been lost, and the labor of transportation much reduced. On the other hand, if the tree is not subjected to this process, it must be carried to the mill at once, and passed through the rollers, which are a foot in diameter, and about three feet long. In crushing, the tender layers are separated from those which are harder and riper, and the different kinds passed through the mill lengthwise, the rollers being placed horizontally. The produce is about 4 pounds of fiber to each tree. "The stalks of the branches give the best fiber, and a larger quantity, as compared with the body of the tree." One hundred pounds of stalk will give about 15 pounds of fiber, net weight, and when a whole tree furnishes 4 pounds of fiber, one-fourth of the quantity is derived from the stalks. One hundred plantain trees can be crushed in twenty minutes, with one horse, allowing five minutes for rest.

After crushing, the fiber is boiled to separate the gluten and coloring matter, carbonate of soda and quicklime being used as chemical agents.

To make three tons of fiber a day, it is necessary to have four boilers of 800 gallons each, and give five boilings in a day, which amounts to 1,650 pounds of net fiber for each boiler, or 6,650 pounds for the four boilers. They require about 300 pounds of soda, and a proportionate amount of quicklime. As the different grades of fiber are pressed separately, they should also be kept separate in the process of boiling, the lighter fibers requiring about six hours to bleach, while the darkest require fully eighteen. Levers are arranged to lift the mass from the kettles or tanks when sufficiently boiled, allowing it to drain into the boiler before it is carried away to be washed. The washing should be thorough, that no extraneous matter may be left upon the fiber, and the work is done by machinery, such as is used by paper-makers, or the arrowroot-makers in the West Indies. After a thorough washing it is hung up to dry, and when thoroughly dried is ready for baling, hydraulic pressure being used for the purpose. It is estimated that a capital of $25,000 is required for carrying on the cultivation of the plantain on an extensive scale, and 18 tons of

* A very full and complete account of this industry is given in "Simmonds' Commercial Products of the Vegetable Kingdom," by a correspondent in Jamaica.

fiber can be produced on 5¼ acres, at a cost of $570, or a little more than $48 a ton.

The plantain may be considered a valuable plant for paper-making, and its fiber might possibly be extracted for this purpose alone at a considerable profit—it has been suggested at half the above figures. Dr. Royle suggested utilizing the plant for this purpose twenty years ago, in India, where the tree abounds, but the suggestion had not been acted upon four years ago, as is shown in an official report recently published in Calcutta, where the plant is mentioned, with many others, as one whose fiber should be utilized for paper manufacture.

As to its strength, experiments by Dr. Royle gave most satisfactory results. Fiber from Madras bore a weight of 190 pounds, while a specimen from Singapore stood a strain of 390 pounds, and Russian hemp bore 190 pounds. "A 12-thread rope of (India) plantain fiber broke with 864 pounds, when a similar rope of pineapple broke with 924 pounds." Compared with English hemp and Manila (see experiments in tenacity, under head of *Musa textilis*), a rope 3½ inches in circumference and 2 fathoms long, made in Madras in 1850, gave the following results: The plantain dry broke at 2,330 pounds; after immersion in water twenty-four hours; tested seven days after, 2,387; and after ten days' immersion, 2,050; Manila rope and English hemp dry gave 4,669 and 3,885 pounds, respectively. Though common plantain fiber is not possessed of the strength of Manila hemp, yet it is fitted for many purposes of cordage and canvas, and some of the finer kinds for textile fabrics "of fine quality and luster."

A sample of fiber of *Musa sapientum* in the collection exhibits the usual characteristics of the plantain, and the two fibers may be regarded as almost identical.

In the New South Wales Catalogue (Philadelphia Exhibition, 1876), it is stated that "*Musa sapientum*, so generally planted in New South Wales for its fruit, yields a fiber second only in value of its kind to that of the Manila hemp, which is obtained from *Musa textilis*."

18.—BROMELIACEÆ.

The Pine-Apple family is an important one, as it contains a plant furnishing not only one of the finest and most beautiful fibers known, but one of the most delicate and delicious of fruits. The species are all fiber-producing, some of them of considerable value. The Southern Moss belongs to this group.

Ananassa sativa.—Pine Apple.—This plant is supposed to be a native of Brazil, and introduced into the East and West Indies, and now found in many parts of the Old World, where it has become so established and apparently wild as to be thought indigenous. It flourishes in Assam, in India, and on the west coast of Africa. In the Philippine Islands it grows in great abundance, and is valued on account of its fine hair-like fibers, from which is woven the celebrated pine-apple cloth of the Philippines. M. Perrottet, however, considers this a distinct species, and named it *Bromelia pigna*.

In the Rungpore district of India the fiber is much used by the local shoemakers for twine, though it is cultivated principally for its fruit-bearing qualities, its fiber being little appreciated.

When preparing the fiber of the pine-apple, the leaves must be manipulated in the green state, as nothing can be done with them when dry. The leaves are laid upon a board, and the epidermis removed with a broad knife. Upon its removal from the upper surface,

the fibers are seen lying upon the lower and denser epidermis, running in a longitudinal direction. Although very fine, the process of bleaching, by destroying the adhesion between the bundles of fibers, renders it so much finer that it can be spun like flax. In the East Indies, where the pine-apple was introduced as early as 1600, the fiber is extensively used in the manufacture of the delicate fabric called piña, as well as for cordage. Piña is considered to be more delicate in texture than any other known to the vegetable kingdom. It is woven from the untwisted fibers of the Ananassa leaf, after they have been reduced to extreme fineness, and after the ends have been glued together to form a continuous thread.

It is claimed for pine-apple fiber that constant immersion in water does not in the least injure it, and the natives of the East Indies increase this property by tanning it, though it is probably at the expense of strength.

The filaments of pine-apple are very fine and flexible and very resistant. They are easily divided after treatment in the alkaline bath, and after being submitted to trituration. The isolated fibers are very fine, of a tolerably regular diameter from one end to the other, but of very different size. The interior canal, which is very perceptible in the largest, is not so in the smaller ones. They are very flexible, curling and crisping readily under mechanism. The points are rarely sharp, and gradully become slender. They are rounded at the end, or, rather, blunt.

In tests of strength pine-apple fiber exhibits superior tenacity. The fiber from Singapore bore a strain of 350 pounds against 260 pounds for New Zealand flax. This last named has been proved equal, and in some experiments superior, to best English hemp. In the Journal of the Agricultural Society of India, vol. iii, p. 152, there is a record of a rope of pine-apple fiber, 3½ inches in circumference, standing a strain of 1,700 pounds before breaking (refer back to experiment with plantain fiber, when same-sized rope was used, under head of *Musa paradisiaca*). Pine-apple fiber is much valued in Brazil.

Bromelia sylvestris.—Wild Pine-Apple.—This is also known as "silk grass," of British Honduras. It is the *Ixtle* and *Istle* of Mexico, and the *Pita* (incorrectly called) or *Piñuela* of Central America. The plant in Mexico is called "*lechuguilla*." This plant also belongs to the pine-apple family, and is widely diffused throughout the tropics, growing everywhere and in all varieties of soil. It is common on the rocky hills of the West Indies, and particularly Jamaica, where the plants are used as hedges and fences. Its leaves are steeped in water by the natives, and, after beating with a wooden mallet, yield a strong fiber. It is in common use for cordage on the island of San Domingo, and is favorably mentioned by Dr. Parry in his report. The leaves from which the fiber is obtained are from 1½ to 3 inches in width and 5 to 6 feet long. They are quite thin and are lined with a fine, tough fiber, which some authorities consider a superior substitute for flax. In portions of Mexico the Bromelia is cultivated for its fiber, which is described as very fine, from 6 to 8 feet in length, and from its fineness and toughness commonly used in belt-making works. It also finds application in the manufacture of many articles, such as bagging for baling cotton, wagon sheets, carpets, &c., besides forming a valuable material for making cordage, nets, hammocks, and similar articles of common use. In Mexico the leaves were formerly subjected to the slow and laborious process of hand-scraping, and, as large quantities of the fiber were used annually, suitable machinery was very much needed. In 1875 this want was supplied by native invention, so that now "Ixtle" fiber is produced in any quantity and in an economical manner. As early as 1820, there reached the port of Vera Cruz, by the pass of the San Juan alone, over 135,000 pounds

of dressed fiber. On the Isthmus of Tehuantepec it is used by the natives in the fabrication of thread, cordage, mats, bagging, clothing, and for hammocks, and the fiber is sometimes made into paper. It is also manufactured into cloth by the Spaniards, for hammocks.

The fiber of the young plants is fine and white, though necessarily short. The more mature the plant the coarser and longer the fiber, so with this knowledge it is an easy matter to select just the quality of fiber desired. The plants are armed with spines or thorns—used by the natives for needles and pins—though these disappear in cultivation.

Specimens of Bromelia fiber, from British Honduras, were brought to the notice of the Royal Society of Arts in 1857, and from examinations then made—

It was ascertained that each fiber contained from five to twelve or more filaments, held together by gummy matter capable of being dissolved by proper processes. Specimens had been passed over the comb or hackle of a flax-mill, and had been pronounced by the most experienced flax spinners (of England) to be greatly superior to Russian flax, and approaching the best description of Belgian in capability of application to the finest textile fabrics.

Squier states that the fiber of this plant is probably more valuable in every sense than those of any other tropical plant, and would seem to be produced more readily than those of *Agave Sisalana*.

Microscopically the fibers of *Bromelia* differ from those of *Ananassa sativa*. "The interior canal is much more apparent and the walls thinner. The fibers often present great inequalities in the diameter of the same specimen as well as in the thickness of the walls."

Among the many samples of bromeliaceous fibers in the Museum there are several examples of "Caragua" or "Caraguata" fiber from the Argentine Republic, which are fine, white, and strong. Royle, in a work on India fiber-producing plants, mentions *Bromelia Karatas*, or the "upright-leaved wild pine-apple," which includes the "Caraguata" of Pisa, and is common in South America. This is probably a variety of *Bromelia sylvestris*.

Dasylirion graminifolium.—Bear Grass.—A sample of the fiber from this plant, without locality or other data than the name given above, occurs in the collection of the department. It is probably of Mexican origin, as the plants of the genus are found in that country; and belonging, as it does, to the Bromeliaceæ, it would naturally inhabit a tropical or subtropical climate.

The fiber resembles Ixtle, is about 2 feet in length, fully equal to it in strength, though in color it is darker, due very likely to improper mode of preparation. A peculiarity of the sample before us is that the filaments are filled with kinks, as though the fiber had been folded upon itself a number of times. These do not impair the strength, however, the breakage point coming oftener between than on the "joints," as these kinks appear to be, for the filament has no stiffness at this point, and, held in the hand horizontally, falls by its own weight at the nearest of these points, as though partially severed. The plants are described as having—

Short stems and densely-crowded linear leaves (which furnish the fiber), drooping gracefully, and generally having a little brush-like tuft of fibers at the point. From amidst these leaves the flower stalks rise to a considerable height, the upper portion being crowded with a dense panicle of flowers.

Tillandsia usneoides.—Spanish or Southern Moss.—This plant, so abundant in the southern portions of our own country, is a native of tropical America, growing in profusion in Central America, West Indies, and portions of South America. In Brazil it is used by the country people to fill mattresses, pillows, cushions, &c., and it is also used for

packing glassware or porcelain. It is largely employed in the arts in the United States, in the manufacture of "vegetable hair," and forms an admirable substitute for curled hair for upholstering purposes.

The outer cellular portion is removed by steeping the plant in water, when the filaments change their color from gray to black, and in appearance closely resemble "hair."

The plant is allied to the pine-apple, belonging to the same family, though, as it is seen in Southern forests, pendant from the branches of the trees in long gray tufts, it has far from the appearance of bromeliaceous plants. There are quite a number of patented machines and processes for the preparation of the fiber, which is, of course, conducted in the South.

19.—AMARYLLIDACEÆ.

Agave Americana.—Century Plant.—In America the plant is known as the American aloe, *Càrata* and *Pita*;* the last name is also given the fiber. It is known in India as *Cutthaler nar* and *Bans-Keora* in Hindostan.

This plant, which is now found growing in many parts of the world, is well represented in the department collection. It gives a brilliant fiber of considerable strength, which is useful for many purposes. The Indians of Mexico and Arizona use it for saddle-cloths and cordage. The "saddle-cloths" are not woven, but are merely masses of fiber of regular thickness, tacked with thread at regular distances, in the same manner that mattresses are secured and the hair kept in place. In the West Indies it is employed by the negroes for making cordage hammocks and fishing-lines, and in Mexico is utilized in the manufacture of ropes for use in the mines, and in some cases for the rigging of ships. In South America it has even been used for large cables. Humboldt mentions a bridge in Quito with a span of 130 feet constructed of ropes of Agave fiber, some of them 4 inches in diameter.

The name *Pita* follows it to Spain and Sicily, where it is used for cordage and mats. It is also made into paper in Mexico, a sample of "Maguay paper" in the museum attesting its value as a paper stuff. The sample is clear and white and of fine texture. In New South Wales "it produces such an excellent fiber, of such strong and durable quality," it is recommended for cultivation for its fiber alone, particularly as "it will grow in almost any situation, and so freely that under favorable circumstances it will flower in from seven to eight years."

The plant is so well known from the examples to be met with in our conservatories that a description seems hardly necessary; however, the leaves are from 3 to 6 feet in length, are thick and fleshy, and formed of hard, pulpy matter intermixed with the fibers; they are armed with sharp spines, both at the point of the leaf and along the margins.

When the fiber is extracted by hand the leaves are crushed and macerated in water, and the fibers separated from the parenchyma by beating. The fiber is contained in roots as well as leaves. Another plan in vogue is to lay the long leaves upon a board, and with a square iron bar held in both hands they are scraped until all the juice and pulp are pressed out, leaving the fiber ready to be cleaned.

Within late years improved processes of separating the fiber have been invented, which will doubtless give it more prominence as a commercial product. A machine for the mechanical extraction of the fiber,

* *Bromelia sylvestris* is also called *Pita* by some authors, though the name properly belongs to *Agave Americana.*

invented in 1867, has been patented by Carlos de la Baquera, of New York City, and in the latter part of the year just passed another machine was brought to public notice by Pedro Sanchez, of Tabasco, Mexico.

The plants come to maturity in about three years, though they do not flower for eight and sometimes twenty years.

Among other uses of the agave it is employed in portions of Southern Europe as a hedge plant, the spiny leaves particularly adapting it for the purpose. Soap is also manufactured from the juice, and the fresh leaves cut in slices are occasionally used as food for cattle. The most important product, however, is the sap, which forms an intoxicating liquor known as *pulque*, from which a kind of brandy is manufactured, as a further product, known as *Aguardiente de Maguay*.

Dr. Forbes Royle states that the India *Pita* has been found superior in strength to either coir, jute, or sunn hemp. In a trial of strength near Calcutta, the tests were made with ropes one fathom long and three inches in circumference, with the following results: The agave or pita broke in a strain of 2,519½ pounds; coir, 2,175 pounds; jute 2,456¼ pounds, and sunn hemp 2,269½ pounds. An experiment with Russian hemp and pita, the first named broke with 160 pounds' weight, and the latter with 270 pounds. These experiments show the great strength of the fiber, which is worthy of more extended cultivation and employment in the arts.

Agave fiber is composed of quite large filaments, white, brilliant, stiff, and light (in weight). They are easily separated by friction, while at the same time preserving their stiffness.

Vetillart states that, viewed with the microscope, the isolated fibers are short, with slender walls, and very large central cavity. They are swollen in the middle, and terminate in a point, the most frequent form of which is that of a spatula blade. They are sometimes lobed or bifurcated, and the thickness of the walls varies in the same fiber. It is very irregular, the exterior profile undulated or toothed to the extremity.

The peasant women of Fayal employ the fiber of the "bitter aloe" in the manufacture of the celebrated "Fayal lace," which has brought such high prices in Paris, where the greater portion of this delicate fabric is sold.

In the museum of the department there is a complete series of the articles in the fabrication of which this fiber is employed. There are about twenty-five women only on the island capable of producing this delicate fabric, its manufacture requiring practice from childhood.

Fine samples of agave fiber were secured at the Centennial Exhibition from New South Wales and Victoria. Dr. Guilfoyle states that in the last named locality "the plant is of quick growth, and thrives exceedingly well."

Agave sisalana.—Mexican grass, Sisal hemp.—Also called grass hemp. It is the *Cabulla* of Central America, and the *Lesquil Henequen* or *Jenequen* of Yucatan, and produces the fiber known as Sisal hemp.

This species of agave is not so widely known as the preceding, as its cultivation seems to be confined to the new world, particularly the West India islands, Yucatan, and Central America. Dr. H. Perrine introduced it into Florida in 1836, together with the *Agave Americana*, and the records of his experiments are among the chief sources of information regarding the plant and its uses. The full and complete collection of Dr. Perrine is most carefully preserved in the museum of this department, having been received from the National Museum a few years ago.

The native method of extracting the fiber is slow and laborious. It

is accomplished by means of rude wooden implements, two examples of which are preserved in the museum.*

The first of these is a thin strip of wood, 2 feet in length by 5 inches wide, notched like a boot-jack at one end, the points, however, being made very sharp. With this the leaf is split into shreds, and afterwards is scraped with the second instrument, a piece of very hard wood, 2 feet long, shaped with three sides, giving it a triangular appearance, and forms three sharp scraping edges. Upon the two ends handles are formed, and the implement is used in the same manner as a currier's shaving-knife.

A chemical process which dissolves the green, fleshy parts of the leaves, leaving the fiber intact, ready for washing, has also been employed.

In Yucatan the two varieties of the fiber are distinguished as the *Yashqui henequen*, which produces the best quality, and the *Sacqui henequen*, which gives the greatest quantity. It is worked by machinery, and from July, 1875, to June, 1876, Yucatan produced 22,000,000 pounds of Henequen fiber, 18,000,000 pounds of which were sent to British ports. The remainder was sent to Cuba and Mexico. I am unable to give the figures as to the American importation in late years, but the amount must be considerable, as the fiber is now in high favor as a cordage material, manufacturers claiming that it has been growing better and better each year in quality. A few figures are given in the latter part of the flax and hemp report, under the heading "Other fibers," which will give some idea of the amount consumed at present in this country. A recent report, published in Yucatan, gives the following figures:

Taking $1\frac{1}{2}$ pounds of fiber for the yearly production of each Henequen plant, we come to the conclusion that at present there are more than 18,000,000 of plants under cultivation. For this number of plants over 420 scraping-wheels are in operation, moved by 220 steam-engines, with a force of 1,732 horse-power, and 30 wheels moved by animal power. Each scraping-wheel cleans daily, on an average, 300 pounds of fiber; so the 450 wheels in existence do not work at present 163 days in the year.

It is estimated that in Yucatan alone a capital of over $5,000,000 is invested in this industry.

A peculiarity of this fiber is that it resists the action of dampness for a greater length of time than hemp or similar fibers, which makes it very desirable in the manufacture of cable-ropes, &c., used in the rigging of ships.

In the Annual Report of this department for 1869, page 257, there is an article on "Jenequen, or Sisal hemp," to which the reader is referred for details of cultivation and preparation, though the article was doubtless written before the introduction of steam-mills and machinery, as the native mode of treating the fiber only is described. I will quote but a paragraph from this report in reference to the cultivation of "Jenequen," or Henequen, in the United States:

There is little doubt that very considerable tracts of land in our own Gulf States would be found suited to the production of *Jenequen*, and the introduction of so important an agricultural staple would be the more desirable for the reason that arid land, so singularly adapted for raising Sisal hemp, would never justify the least outlay in money or labor for the raising of any other crop.

Samples of Sisal hemp leaves, fiber, and fine cordage were brought by Dr. Parry from Santo Domingo and deposited in the museum. These samples are very fine, and exhibit the strength and beauty of this fiber.

Fourcroya gigantea.—Giant Lily.—This is also the *Cabouja*, or *Cabuja*,

* These were also presented to the department with the Perrine collection.

of the West Indies and South America. The plant is closely allied to the agaves, and is found throughout tropical America. It grows in Algeria and Natal, and is said to be common in St. Helena. It has also been introduced into Madras, and in Australia. It is of moderately quick growth, and attains great perfection. Like the agaves, these plants have long-lived massive stems, immense fleshy leaves, and produce their flowers after many years upon tall central stems in pyramidal, candelabra-like form.

The fiber is very similar to that of the agave, and indeed is sometimes called *Pita*, particularly in South America. In Brazil it is called *Peteria*, and is described as "a white fiber, of a silken luster, but of little tenacity." In Venezuela it is called *Cocuisa*. Dr. Ernst, in the catalogue of the Venezuelan Department (Exhibition, 1876), states that the fiber is very *strong*, and is used for cordage and gunny bags. It is prepared in the same manner as Sisal hemp. Samples of the Venezuelan specimens are dyed in aniline, to show that it will take color.

I was shown a sample of fiber this winter, sent to a New York manufacturer from one of the West India Islands, which I am quite sure was from the *Fourcroya*. When received, the manufacturer was delighted with it, and at considerable expense sent down an agent with machinery to prepare it for cordage manufacture. From causes not explained, no results were attained by this venture, and the one specimen only remained—a costly monument to an unsuccessful fiber experiment, or, perhaps, to misplaced confidence. But this does not detract from the value of the fiber in question, and shows, if the sample was *Fourcroya*, that the fiber was considered worthy of utilization.

Fourcroya Cubensis.—Samples of fiber from this plant, closely resembling the preceding, were brought from Santo Domingo by Dr. Parry. The plant is met with in limited districts, and "the large, fleshy leaves yield the fine, white fiber so extensively used in the manufacture of ropes." These specimens are preserved in the museum, together with a sample received from Queensland (Exhibition, 1876), under the name "Cuba hemp."

Doryanthes excelsa.—Spear Lily.—Habitat, East Australia. This fiber was met with in the New South Wales and Victorian collections received with the Australian exhibit (Exhibition, 1876). The plant is "a tall, straight stem, 20 feet high, springing from an aloe-like tuft of broadly ensiform-spreading basal leaves, the stem itself clothed with much smaller appressed ones." The stem terminates in a bulky flower-head composed of crimson flowers. It is sometimes met with in cultivation. According to Guilfoyle, who has prepared its fibers experimentally, the leaves are a complete mass of fiber of great strength, fit for strong ropes, matting, cordage, &c. It can also be employed in paper-making, with good results. It is of moderately quick growth in Victoria. The specimen has not been thoroughly prepared, as some of the filaments are quite white, while the majority are a rust red. They are stiff but fine, the white fibers being smooth and glossy. In strength, the sample before me is considerably below the average of fibers in this family.

20.—PALMACEÆ.

We now come to a group of plants, many of which are fiber producing, and some of them of great celebrity.

The palms are found in tropical countries in all portions of the world, and are among the most useful plants to man in the whole vegetable kingdom. Some of the fibers derived from them are of great strength,

and one in particular, that of the cocoa palm, most valuable as a commercial product.

Cocos nucifera.—The cocoa palm.—The fiber of this palm is known to commerce as *Coir*, *Kair*, and *Cocoa fiber*. Its names are as various as the countries in which it grows. Among the forty or more appellations that have been used to designate it, the following may be given as the most liable to be met with. In the Malay Archipelago it is called *Anoer; Djai soi*, in Borneo; *Kelpo*, &c., Java; *Jouz-hindie*, Arabia; *Narkol*, *Nasil*, &c., Bengal; *Oteri*, New Guinea; *Sinlo-Kawa*, Japan; *Nadi Nali* or *Nari Kera*, Sanscrit, &c.

There is hardly a tropical country on the face of the globe where the cocoa palm does not flourish, and it is impossible to ascertain its native country, though it is thought to be indigenous in some part of Asia, perhaps Southern India.

In the Coromandel and Malabar districts, and in the adjacent islands, it grows in the greatest luxuriance, preferring the sandy and rocky seashores to the higher country, though it is often found some distance inland. It is common in Africa, and abounds in America and in the West India Islands. Dr. Parry found it plentifully on the island of Santo Domingo, where it forms groves on the sandy beaches at the outlet of mountain streams, and bears fruit abundantly.

Its extensive geographical distribution is accounted for by the fact of the tree growing in such close proximity to the sea, that the fruits falling on the beach are washed away by the waves and afterwards cast upon some far distant shore, where they readily vegetate. It is in this way that the Coral Islands in the Indian Ocean have been covered with these palms.

The fiber of the cocoa palm is contained in the husk or rind of the nut, which is composed of a mass of *Coir*, as the separated fiber is called. The husks are removed by forcing the nuts upon sharp iron or wooden spikes fixed in the ground, one man being able to remove the husks from 1,000 nuts daily. The proper time for cutting the fruit is in the tenth month, as the fruit must not be allowed to get thoroughly ripe, as the fiber becomes coarser and more difficult to twist, and must remain longer in the soaking pits, which is a disadvantage, as the fiber is rendered darker. These pits in some of the islands are merely holes in the sand, and the nuts lie under the influence of salt water a year, kept from floating away by large stones placed over them. Sometimes the nuts are soaked in fresh-water tanks, and, as the water is not changed, it becomes, in time, very foul and dark colored, which affects the color of the coir. After soaking, the fiber is readily extracted by beating. Fresh water is said to weaken the fiber, and in fact, too long soaking will produce this result in any event. The coir from the islands of Kadamat, Kelton, and Chetlat, in the Laccadives, is said to be of the best description, and the manufacture into cordage, is done entirely by women. After it is taken from the pit and sufficiently beaten, the extraneous matter is separated from the fibrous portion by rubbing between the hands. After it is thoroughly cleaned, it is arranged into a loose roving, preparatory to being twisted, which is done in a very ingenious manner between the palms of the hands, so that it produces a yarn of two strands at once. (Samples of this can be seen in the museum.)

Three large coast cocoa-nuts will yield 1 pound of coir, measuring about 130 feet, whereas 10 small inland nuts are required for 1 pound, but it will give over 200 feet. Two pounds of such yarn, averaging from 70 to 75 fathoms, are made up into *sooties*, of which there are 14 in a bundle, averaging about a *maund* (28 pounds). A Mangalore *candy* (560 pounds) will thus be the produce of 5,600 nuts, and should contain 20,000 fathoms (120,000 feet) of yarn.

Coir fiber is used by the Spaniards of the South Seas instead of oakum for calking their vessels, and it is claimed that it will never rot. Coarse cloth is sometimes made from the fiber, which is used for sails. The principal use of coir, however, in the commercial world, is for cordage and matting. "The character of coir has long been established in the East, and is now in Europe, as one of the best materials for cables, on account of its lightness as well as elasticity." Ships furnished with coir cables have been known to ride out a storm in security while the stronger made, but less elastic, ropes of other vessels snapped like packthread. Coir cables were used extensively in the Indian Seas until chain cables were introduced. It is rougher to handle and not so neat looking as hemp rigging, but is well suited to running rigging where lightness and elasticity are desired, as for the more lofty sheets; it, however, is too elastic for standing rigging. In vessels of 600 tons it is generally used for lower rigging.

Coir fiber appears in the form of large, stiff, and, as has been stated, very elastic filaments, each individual of which is round, smooth, very clean, resembling horse hair. It possesses a remarkable tenacity and curls easily. Its color is a cinnamon brown. These filaments are bundles of fibers, which, when treated with the alkaline bath and ground in a mortar, are with difficulty separated by the needles for microscopic examination.

The individual fibers are short and stiff, their walls very thick, notwithstanding which this thickness does not equal the size of the interior canal. The surface does not appear smooth; it is often sinuous and the profile appears dentated. The diameter is not very regular. The points terminate suddenly and are not sharp. The walls appear broken in places as if they were pierced with fibers, corresponding with the fissures of the sections.

Tests of coir cordage, by Dr. Wight, gave the following results: *Hibiscus cannabinus* broke with 190 pounds strain, coir broke with 224 pounds, but bowstring hemp (*Sansevieria zeylanica*) required a strain of 316 pounds to break it. In another series of experiments, made at the office of the marine board in Calcutta, plain coir stood a strain of 823 pounds, when a remarkably fine sample of European hemp stood 1,967 pounds. In this test the coir stood No. 12 in strength and No. 1 in elasticity, stretching 32 inches against 9½ inches for the hemp. Unfortunately the length of rope was not given, though its size was 1½ inches in circumference.

The cocoa palm has other uses than for food and fibers, which are of sufficient interest in connection with its textile uses to briefly mention. The cocoa-nuts are sometimes used for illuminating purposes, to light roads, and an excellent charcoal is yielded by the burnt shells. These in their entire state are manufactured into a great variety of vessels for household use. The tree itself is used in the manufacture of small boats, frames for houses, rafters, spear-handles, furniture, and fancy articles of different kinds. It is exported under the name of porcupine-wood. "The Cingalese split the fronds in halves and plait the leaves so nicely as to make excellent baskets, and they form the usual covering of their huts, as well as the bungalows of the Europeans." These dried fronds also furnish fuel and are used for torches, or they are made into brooms by tying the mid-ribs together. The leaves furnish mats, baskets, and screens, and combs are made from the mid-rib of the leaflets in the Friendly Isles. Mats are also made of the cocoa-nut leaf cut out of the heart of the tree, which are described of fine quality, and used in the Laccadive Islands as sails for their boats. A downy fiber is also taken from the plant, which is used to staunch the blood in wounds after the manner of lint.

Cocoa-nut oil is one of the best known products of the palm, especially as it is employed in the manufacture of stearine candles. In the East it is employed as lamp-oil, and also for anointing the body. Fifteen cocoa-nuts produce about two quarts of oil. The drink known as toddy or palm-wine is derived from the flower spathes before they have expanded. It is also distilled, and produces an intoxicating liquor or *arrack*. It is also made into vinegar, or, if it is not allowed to ferment, may be made to yield *jaggery* or sugar, which is brown and coarse.

We have thus hastily indicated some of the uses of this most interesting and valuable of plants, which furnishes to commerce a most useful fiber, and to the natives of many lands food, drink, raiment, house, household articles and utensils, besides supplying their wants in many other ways.

The collection of the department contains a full series of coir in the various stages of preparation, as the husk, the loose fiber, yarn, rope, matting, brushes, and coir "curled hair" used for upholstering. It is much esteemed in India for stuffing mattresses and cushions for couches and saddles. Very little "coir" is at present imported into the United States. An interesting fiber specimen is a network of fibers taken from the petiole of the leaf. As seen upon the tree at the bases of the young fronds, it is beautifully white and transparent, but at maturity it becomes tough and coarse, and of the same color of coir. It may be stripped off in large pieces, and the fibers are so straight and cross each other so regularly, they are used to strain cocoa-nut oil or palm-wine.

Cocos crispa.—Corojo Palm.—I am not certain as to the name of the plant from which this sample of fiber was obtained. It was received from the West Indies through the Interior Department, under the name *Coracco* or *Corojo* Palm. Two varieties of Corojo are given in the catalogue of M. Bernardin, the "*Corojo de la terre*" from the West Indies, stated to be *Cocos crispa*, and the *Corojo*, *Corozo*, or *Coquyol* from Central America, without name. Squier states that the Coroso, Coyol, or Corojo palm * abounds in dry and rocky locations in Central America and Cuba, and some other portions of tropical America. It is described as a tree 20 feet high, producing a large cluster of nuts, with a hard shell, which yields an oil similar to that of the cocoa-nut. The trunk and leaves of the coyal are armed with long, narrow, hard spines. "The leaves are lined with a long and excellent fiber called *Pita de Corojo*, from which ropes and cords are manufactured. The fibers are equal to those of Henequen, from which they can hardly be distinguished."

The fibers, as examined, present a ribbon like form, flat and smooth, and as thin as paper. By rolling between the hands, this ribbon breaks up into innumerable filaments, some of them of great fineness, though when viewed with a magnifying glass are found to be quite irregular in size, and not altogether smooth.

It might prove a valuable fiber for cordage, though a drawback (in the specimen examined) is the presence of little spines, doubtless those mentioned by Squier, which are as sharp as needles, and half an inch in length. They are not readily seen, but by grasping a handful of the fiber in the hand, they make their presence known with painful surety.

As to the fiber being "equal to Henequen, from which it can hardly be distinguished," the present fiber is far superior in point of strength to any other fiber in the museum, and in point of resemblance is in no respect like it, either in color, texture, or general appearance. Its tensile strength with a lateral strain is simply enormous; by giving the fiber a sharp twist, however, it parts more easily.

* This is another illustration of the manner in which native names are multiplied.

A juice is extracted from the pulpy heart of the trunk of the Corojo, which, when fermented, becomes intoxicating, like the Maguay. This pulpy heart is also fed to cattle in times of drought when other vegetation is destroyed.

Attalea funifera.—Monkey or Para Grass.—This palm is indigenous in South America, and in Brazil is known by the name Pissaba. In Venezuela it is called *Chiquechique.*

The species of the genus *Attalea* are all lofty trees, with large pinnate leaves, and yielding large clusters of nuts. Those of *A. funifera* are known as Coquilla nuts. The stem of the tree rises to a height of 20 to 30 feet, and is straight as an arrow. From the top of this springs a tuft of pinnated fronds or leaves, often 20 feet in length. The fiber is derived from the decaying of the cellular matter at the base of the leaf stalks, liberating the long filaments in large quantities, where it hangs in tufts of ten or twelve feet in length. It is used very largely on the Amazon for cordage and for brooms. Its principal export is to France and England, where it is made into brushes for street-sweeping machines—chiefly in London and Paris. It is one of the principal branches of commerce between South America and the European markets, eight hundred tons having been exported to England alone in one year.

The filaments of this fiber are exceedingly coarse, stiff, and wiry, but smooth and round. It is quite strong when subjected to lateral strain, but, bent sharply, is found to be quite brittle, and breaks with ease. Its color is a dark reddish-brown, and the woody interior is cinnamon-colored.

A bale of fiber, together with a number of brooms made from it, for household use, was received from the Brazilian Commissioners (Exhibition, 1876). Samples of cordage were also received with the Venezuelan collection, called *Cable de Rio Negro.* These *cables* are made in 200-feet lengths, and cost 85 cents to $1.40 per inch of circumference. That is to say, a cable 200 feet long and 3 inches in circumference would be worth, at $1 per inch, $3. The cordage is durable and light; swims on the surface when placed in water.

Oreodoxa regia.—"Palma real," of West Indies.—Six species of palms belonging to the genus *Oreodoxa* are described—all natives of the West Indies or tropical America. Dr. Parry, who brought the museum specimens from Santo Domingo, says the large sheaths of the leaves supply material for thatching, and lining the sides of houses. It is also used for floor matting and coarse baskets. The external ring of hard woody fibers on the main stem is pressed out into thin sheathing boards. The fruit of the species is in common use on the island for feeding hogs and cattle.

Caryota urens.—The Jaggery Palm.—Samples of fiber from this palm, as well as tow prepared from it, were received from the Philippine Islands and from Victoria, the latter prepared by Dr. Guilfoyle. The tree is a native of Ceylon, and thrives in many parts of India, as Malabar, Bengal, and Assam. It is also indigenous in Northern Australia.

In Malabar it is called *Erimpannah*, and the Cingalese name is *Kittul* or *Kittool.* It is a beautiful tree, growing to a height of 60 feet, and is surmounted by an elegant crown of graceful curved leaves. The tree is a foot in diameter. The fiber, which is black and very coarse, is used for making ropes, brushes, brooms, baskets, &c., and a woolly substance or scurf scraped from the leaf stalks is used for calking boats. It is also extensively used in machine brushes for polishing linen and cotton yarns, for cleaning flax fiber after it is scutched, for brushing velvets, and other similar purposes. In Ceylon the black fiber is manufactured into ropes

of great strength and durability, which are used for tying elephants. It is both regular and compact, and its manufacture exhibits considerable skill. In Australia, Dr. Guilfoyle says, it is used for making paper.

The fiber is brownish black, the filaments straight, smooth and glossy. It exhibits considerable tenacity, and will bear twisting, as the fiber is somewhat elastic. Some of the filaments resemble horse-hair very closely, and drawn between the thumb and nail of the fore-finger curl as readily as coir.

This palm is most useful to man, however, by yielding palm wine, which is obtained from the flower stalks. From this sugar is manufactured in large quantities, this and two other species of palm supplying the whole amount of sugar used in Ceylon.

The central or pithy portion of the stalk yields a farinaceous product equal to the best sago, which the natives use for food in the place of bread, or boiled into thick gruel. The fruits are reddish berries about the size of nutmegs, and have a thin, yellow, acrid rind.

Chamærops (species).—Palmetto.—The Palmetto is only represented in the Museum by samples of its fan-like leaves and simple stalks, which are very tough, and are capable of being formed, when split, into baskets, coarse cordage, and a variety of objects. There are specimens of paper in the collection made from the leaves of a species of Palmetto growing in Florida. The saw-palmetto, *Chamærops serrulata*, which grows on the coast of South Carolina and in Georgia, is sometimes used for stuffing mattresses; they are split into shreds with a hackle, then boiled, and dried in the sun for a few days, when they are ready for use. The negroes also make hats from them. The leaves of the smaller kinds of cabbage palmetto, *Chamærops palmetto*, are sometimes used as a thatch for barns and outhouses in the Southern States, and are quite durable. Hats are also manufactured from them, the leaves being whitened by brushing with a solution of oxalic acid once or twice, after which they are bleached by exposing to fumes of burning sulphur. They are also made into baskets. The spongy portions of the stem furnish a good substitute for scrubbing brushes, and the palmetto logs have been used for building purposes, particularly for wharves. From the dwarf palmetto, *Sabal palmetto*, fans are manufactured.

Squier states that the fiber of an allied species (*C. humilis*) is used by the Arabs to mix with camel's hair for the cloth of their tents, and also for cordage. It is also used for sails, and "has been extensively employed in France under the name of 'African hair' in the manufacture of carpets." It is said that the fiber, divested of its glutinous matter, may be made as fine as flax. "It has been successfully made into sail-cloth, carpets, thread, and paper."

In the south of Europe palmetto fiber is extensively used in the manufacture of hats, brooms, baskets, &c., and for thatching houses. The French also manufacture a substance from it, which is used as a substitute for horse-hair, which it much resembles.

Palmetto fiber is also manufactured in this country into a kind of mattress material, a number of machines having been patented in the last five years for its preparation. It goes under the name of "hard twisted palmetto fiber," the source of supply being the saw palmetto, which grows abundantly in Florida and other portions of the Southern States. It is manufactured at about 5 cents a pound, its use being for the upholstering of mattresses. Although produced so abundantly the manufacturers are obliged to compete with imported fiber brought from Africa. The American product is held to be superior to the imported fiber, yet the manufacturers desire a little protection in the shape of a heavier duty

on the African product. A manufacturer in Volusia County, Florida, thus writes:

> There is a very great hindrance to the successful manufacture of this fiber here by the importation of the African fiber, which is the product of convict labor in a French prison at or near Algiers, and the only means of encouragement * * * would be a heavier duty on the imported article.

The palmetto also makes a fine sample of paper, and a patent is held by Mr. J. P. Herron, of Washington City, for a process for reducing the leaves. I have examined samples of the paper, but can give no facts as to the extent of manufacture.

Astrocaryum tucuma?—I question this specimen of Brazilian fiber, as it was only labeled "*Aucum ou Aicum.*"* The fiber, however, is that of a palm, and agrees in description with that of the *Tucum* of Brazil, the species given above. The fiber is obtained from the young leaves, and is readily secured, as it lies just under the epidermis of the leaf, which is so exceedingly thin that it is easily rubbed off, leaving the fiber white and clean. In strength it is said to be equal to flax, and the filaments are so fine that it has received the name of vegetable wool. In the specimens received by the department the fiber has not been cleaned, yet in some portions the bundles of filaments are clear and white, showing off the fiber to the best advantage.

This fiber seems sufficiently strong for fine weaving, and from the ease with which it is separated might be obtained very cheaply. Its use in Brazil is for the manufacture of nets, fish-lines, and hammocks.

Another species, *A. vulgare*, is found in British Guiana, Trinidad, and other portions of South America.

——— ——— (?) Accompanying the specimen described above was a bundle of reddish fiber, resembling *coir* in color, but very soft and fine, which was gathered from an unknown palm tree by S. L. da Costa Leite, Minas Geraes, Brazil.

The specimen is a tangled mass of fiber, the filaments of which, when carefully extracted and twisted into pack-thread, are tolerably strong. I do not know in what form the fiber appears upon the tree, or how it is produced; nor can I find any reference to its preparation, uses, or value other than a mere mention in a little brochure† issued by the Brazilian commission (Exhibition, 1876). The author states that the tree grows upon Doce River, and "from its leaves and petals there come filaments which, seen in a mass, have the appearance of wool. * * * Factories should be considered fortunate to be able to count it in their treasury of *materias primas*." The fiber is not to be compared with the preceding in tenacity, though the filaments are finer, softer, and more glossy.

21.—PANDANACEÆ.

Carludovica palmata.—This is a stemless species of screw-pine found in Panama and on the coasts of New Granada and Ecuador. It grows in shady places, and its leaves, which are shaped and plaited like a fan, are borne upon three-cornered stalks 6 to 12 feet high.

It is interesting as furnishing the material from which the Panama hats are made. Those of the best quality are plaited from a single leaf

* While authorities agree that *Tucum* is an *Astrocaryum*, *Bactris setosa* is mentioned as the *Tucum* in a volume on the resources of Brazil distributed at the Exhibition of 1876, and *Astrocaryum* is called the *Tucuman*. In the list of fibers by Bernardin, *Bactris* is called *Tecum*.

† "Historical Notes concerning the Vegetable Fibers exhibited by Severino L. da Costa Leite," by Nicalan J. Moreira, M. D.

without any joining, the process often occupying two or three months. The leaves are cut young, the stiff parallel veins removed, when they are split into shreds, immersed in boiling water for a time, then dried and bleached in the sun.

Pandanus utilis.—The screw-pines, of which there are 30 species or more, are most abundant on the islands of the Indian Archipelago and on the Mascaren Islands. Species are also found in parts of India. Some of them grow to a large size, though the majority are but 10 or 12 feet high.

The most useful species is *P. utilis*, the *Vacoue* or *Bacoua* of Mauritius, which is cultivated for the sake of its leaves, which are made into sacks for coffee, sugar, and grain. They are also employed for cordage in the South Sea Islands, as well as for covering huts and making matting.

The leaves are not cut till the third year, and are regularly cropped every second year afterwards. A plant will yield leaves enough for two large bags. The leaves are prepared as soon as taken from the tree, the operation consisting merely in splitting the leaves into fillets, which are three-fourths to one inch broad at the base, but taper to a point. They are 3 to 4 feet in length. "One of them will support the weight of a bag of sugar, or 140 pounds, without breaking."

The sample of fiber was prepared by Dr. Guilfoyle at the Melbourne Botanic Gardens, and was taken from dead leaves of the screw-pine. It is quite strong, though poorly prepared, and very dark colored. The fiber should be smooth, white, and lustrous.

Among other species *P. candelabrum* is the chandelier-tree of Guiana, so named from its manner of branching. The fruit or seeds of some of the species are eaten.

22.—LILIACEÆ.

This family contains a large number of fiber-producing plants, several species of which are not only well known, but are exceedingly valuable in a commercial point of view.

The Yuccas, so common in our own country, belong to this family, and the best known old-world representatives are the "New Zealand Flax" plant, and the species furnishing the famous "Bow-string Hemp" of India.

Phormium tenax.—New Zealand flax.—Habitat, New Zealand. It has also been introduced into Australia, specimens having been received from Victoria. The several varieties are: *Harakeke*, the common variety of the low lands, *Paritanewha*, the yellow variety of the high regions or hills, and *Tihore*, a superior quality. It is also called *Koradi* or *Korere* by the natives, while the fiber is known by the name *Muka*. Captain Cook first brought this fiber to the notice of Europeans, he having found it in common use by the natives of New Zealand, as he speaks of "a grass plant like flax, the nature of flax or hemp, but superior in quality to either, of which the natives make clothing-lines, &c." It grows on the north and south coasts of New Zealand, and is cultivated in Australia, though to no great extent. It was brought to Ireland by Underwood in 1798, and has been grown successfully in the open ground in gardens in Waterford, Cork, Limerick, Dublin, and Wiclow counties. It also flourishes on the west coast of Scotland, though the winters have occasionally been too severe for it. The leaves of the plant in Ireland grow to 5, 6, 7, and 8 feet high, and it is propagated by offsets which are not removed until the parent root is four years old.

The plant forms large tufts, and has sword-shaped leaves, growing in opposite rows, and clasping each other at the base. One variety forms leaves 5 and 6 feet long, while another is not more than half the length. Mr. Salesbury, of the botanic garden, Chelsea, found that plants three years old will produce on an average 36 leaves, besides a number of offsets. Six leaves have produced one ounce of dry, available fiber after having been scutched and cleaned, at which rate an acre of land cropped with these plants, growing 3 feet apart, would yield more than 600 pounds of dressed fiber. The leaves being cut in the autumn, others spring up anew the following summer. It is said that the plant may be shorn of its leaves in the morning, and before the sun has set be ready for weaving into cloth. Royle states the leaves are cut when full grown, macerated in water for a few days, and then passed under a weighted roller.

The principal operation is scraping and then separating the fibers with the thumb-nail, after which combs are employed for a more minute separation. The fibers are subsequently dried in the sun, and are perfectly white—some short and strong, others fine and silky. According to the reports published by the New Zealand commissioner at the Exhibition of 1876, the *Maoris* (or natives) only use a portion of the fiber upon one side of the leaf, the leaves being selected with great care. They scrape the leaf with a muscle-shell, or piece of hoop-iron, on the thigh, after which it is soaked in water and then dried. Their finest samples are obtained from particular varieties of the plant, only the youngest and best leaves being used, and careful attention being paid to the manipulation. "This native-dressed fiber, however, constitutes but a small portion of the fiber actually prepared on the island, as large manufactories have been erected, where the fiber is stripped by machinery." Two modes of dressing the fiber are practiced, known as the "cold" and the "warm" water dressing. The leaves of the flax are fed to a machine called a stripper at the rate of 100 to 120 feet per minute. The drums of these stripping-machines are driven at the rate of 1,000 to 2,000 revolutions per minute, their diameter being from 14 to 20 inches. After passing through the strippers, the partially-cleaned fiber is hand-washed in bundles of about 20 leaves; these bundles are suspended in water, and are allowed to soak for about two hours; the fiber is then spread out on the bleaching-ground for a time, which varies according to the weather, and then hung on lines to dry. It is then either scutched or hackled, or both, packed in bales, and pressed for shipment. When the stripper is in good order, and the fiber has been fairly cleaned, the loss in scutching amounts to from 3 to 5 cwt. per ton, and in hackling from 2 to 3 cwt. In the warm-water dressing the same operations are gone through with, with the exception that the fiber is washed and placed to soak from six to twenty-four hours in tanks filled with warm water, which is either kept heated by means of fire or a steam-pipe.

New Zealand flax fiber is almost white in color, flexible, soft, and of a silky luster. The bundles of fibers form filaments of unequal size which are easily separated by friction. It has considerable elasticity, but readily *cuts* with the nail. Microscopically examined, according to Vetillart, the fibers are remarkable for their slight adherence. The individual fibers seem very regular, having a uniform thickness, and the surface is smooth; they are stiff, straight, and very fine, and the central cavity is very apparent.

As to tenacity, Royle gives the breaking point of New Zealand flax, compared with flax and hemp, as 23.7 to 11.75 and 16.75, respectively. In the official hand-book of New Zealand it is stated that "during a

late severe gale at Auckland it was found that flax rope, when subjected to the same strain as Manila hemp (*Musa textilis*), remained unbroken, while the other gave way."

The collection of New Zealand flax samples in the museum is both large and fine, the finest in the United States, as the New Zealand exhibit at Philadelphia was made with great care, over 100 different samples of the raw and manufactured flax having been sent, and this entire collection was handed over to the United States Government at the close of the Exhibition, with the exception of some small duplicate samples taken by representatives of one or two industrial institutions.

This series illustrates well the native methods of preparing the fiber, and samples of native dyed (black) fiber are also shown. The machine-prepared series is very full, and the samples of manufacture include nearly everything that could be made of fiber. In cordage there are three-inch cables and ropes of all sizes, horse halters, small cordage, lead-lines, fish-lines (for sea fishing), and twine of the finest finish. The series of mattings illustrate the many ways that the fiber may be used in the household, as door-mats, parlor and bed-room mats (in colors), and hearth rugs, while the finer kinds of fiber are made into cloth not unlike linen duck, into satchels, table-mats, shoes (a kind of sandal), sacks, &c. Floor matting, carriage and railway mats are exhibited in variety, plain and in colors. The nets, of which there are many samples, can hardly be told from linen both in color and finish. It is hardly necessary to state that these are not of native manufacture, as much of the fiber is exported, made up into the various articles enumerated. This is due to the fact that the English rope-makers will not pay for flax fiber a price proportionate to that given for Manila hemp, and it has, therefore, been found more profitable to manufacture at home and export the rope rather than the baled fiber.

From an examination of some of the museum samples, which seem to the touch as soft as the finest flax, I have no doubt many beautiful fabrics could be made, and finer than that now shown.

Murray, in a pamphlet regarding the plant, speaks of bed-ticking being made from it, and states that he has seen "fine fabrics of various kinds, affording demonstrative evidence that its fiber is susceptible of being woven into tissues of the most delicate description."

Besides the specimens here enumerated, there is a fine sample from Queensland, and a small series received from the Smithsonian Institution (1869), doubtless originally from New Zealand.

It may be interesting to mention that in the five years from 1867 to 1871, inclusive, as gleaned from the official hand-book of New Zealand, flax fiber was exported to the value of £280,827, or nearly $1,500,000. The average for the five years is £56,165, the higest exportation being in 1870, when the sum of £132,578 was realized from the industry by export alone. In the province of Westland the flax grows luxuriantly on the banks of rivers, and in swamps, and if properly cultivated, and by stripping only the outer leaves of the plant twice a year, it is claimed that each acre of land would yield more than two tons of marketable flax. In many portions of New Zealand the plant grows wild, and the right to cut leaves from the waste lands may be procured from the government at a very low cost.

According to latest official accounts, the quantity of flax produced has steadily diminished, in Auckland, as well as other localities; this is due to the present low prices of the fiber, mill owners finding that £18 to £20 per ton will not remunerate them. In this country Sisal hemp has driven New Zealand flax from the market. The chief cost in

connection with flax-mills is the motive power. The machines are all locally made, of simple construction, and cheap. The profits from the preparation of the flax depend in a great measure upon the situation of the mill, and the cost of getting the green leaf to the mill, and the fiber to market. The building for a flax-mill need not be large or expensive, but it must have a dry store-room, and a baling press. The work in these mills is largely performed by women and boys.

Sanseviera zeylanica, Sanseviera guinensis, Sanseviera latifolia.—"Bow-string Hemp," African Hemp.—These three species are represented in the Museum collection by large samples of fiber received from the Queensland exhibit (Exhibition, 1876).

The name Bow-string Hemp, generally given to the first-named species, has also been applied to other plants of the genus *S. guinensis*, being called African Bow-string Hemp. *S. zeylanica* is the best known, however, and is common on the Ceylon coast, from which it takes its name. The plant has been known and prized in India from remote antiquity under the name of *Murva*. In the catalogue of Indian fibers (Exhibition, 1862), it is called *Moorga*, *Mazool*, and *Moorgavee.**

It is at present known under the vernacular name of *Murgaci*, *Murga*, and *Mazool*. Its sanscrit synonym is *Goni*. The genus *Sanseviera* abounds on the coast of Guinea, around Ceylon, and along the Bay of Bengal, extending to Java and the coasts of China. They are stemless, perennial plants, throwing out runners, and having only root leaves, which are thick and fleshy, and usually sword or lance shaped, with sheathing bases. They flower from January to May, and the plants grow wild in the jungles. They are easily propagated on most every soil, from the slips which issue in great abundance from the roots, requiring little or no care, and not requiring to be renewed often, if at all.

Dr. Buchanan found this plant employed in the manufacture of cordage at Bangalore, and bow-strings are still made of it in the Sircars, and along the coast of Bengal. In the interior of Bengal it is equally common and wild, but not so largely used for fiber. The leaves are 3 or 4 feet long when the plant is cultivated, and the fiber, which extends the whole length, is separated from the pulpy portion. The native method of preparing the fiber is to place these leaves "upon a smooth board, then press one end of the leaf down with one of the great toes, and with a thin bit of hard stick, held between the two hands, they scrape the leaf from them, and very quickly remove every part of the pulp." This is also accomplished by steeping the leaves in water until the pulpy portion decays, when the fiber is washed and cleaned, though in some cases steeping dissolves the fiber. It is estimated that 40 pounds of fresh leaves 3½ or 4 feet in length will yield a pound of cleaned fiber, or over 1,600 pounds of cleaned fiber per acre, at a gathering; with a favorable season two such gatherings may be assured annually.

Royle states that the untwisted fiber will bear a strain of 280 pounds compared with Agave, which bore 270 pounds, though Dr. Wight's experiments gave 362 pounds for Agave to 316 pounds for the *Sanseviera*. Dr. Roxburgh ascertained that a line of Moorga fiber 4 feet long bore a weight of 120 pounds, when a cord of the same size, made of Russia hemp, bore but 105 pounds. After remaining in water 116 days, the former bore a weight of 39 pounds, while the latter was entirely rotten. It is not considered equal to Manila hemp.

Fiber of *S. guinensis*, which is sometimes introduced into the markets

* Also spelled Moorgahvee.

of Europe, has been thought by some to be superior to New Zealand flax. The strength of its fiber, as tested by the Agri-Horticultural Society of India, was found sufficient for hawsers and cables, while their fineness and tenacity are attested by their being used by jewellers for thread upon which to string pearls.

S. Roxburghiana is considered by English authorities as a distinct species, common on the Bengal coast, and larger than the Zeylanica, though Royle does not admit it.

S. lanuginosa is probably a distinct species; it is called *Kotu-Kapel*, and found on the Malabar coast. This plant, upon experiment, has produced fiber as fine and soft as human hair, and possessing extraordinary strength and tenacity. Very superior examples have been likened to raw silk, and the firmness of the fiber "induced the Rev. J. Garrow to have it woven into cloth, which he declared was as fine a piece of cloth as he had ever seen." The fiber takes color readily. *Sanseviera* fiber was formerly considered a valuable paper stock at Trichinopoly, where the tow was used, while the fiber served as packing for steam-engines.

Considered microscopically, "the fibers are fine, and constitute a white, brilliant filament, possessing a stiffness that does not disappear with friction. The fibers are hollow, straight, and smooth, with walls of uniform thickness. The central cavity is large. The points are sharp and slender."

In *S. latifolia* the bundles are large, and are slightly refined by friction. It corresponds in general appearance with the *Zeylanica* given above.

Yucca aloifolia, *Yucca angustifolia*, *Yucca baccata*, *Yucca filamentosa*, *Yucca gloriosa*.—Variously named Adam's Needle, Spanish Bayonet, Bear Grass, Aloe-leaved Adam's Needle, &c.—The collection contains quite a series of fibers in various stages, manufactured from one or another of these plants. The *Aloifolia* and *Gloriosa* are known by the common names of Adam's Needle, Spanish Bayonet, Dwarf Palmetto, &c. The *filamentosa* is sometimes called Bear's Grass, Silk Grass, Eve's Thread, &c. They thrive in nearly all portions of the United States, and flourish in the poorest soils. *Y. gloriosa*, also called *Petre* by the Mexican Spaniards, according to Nuttall, "is used for cordage, ropes, &c., as well as for packing cloth, and is extremely durable." Elliott, in his Botany of South Carolina, speaks of it as one of the strongest fibers of the vegetable kingdom.

Natives of the warmer portions of the United States, they thrive in Europe, Africa, India, and Australia. One species finds its way into our gardens, even in more northern sections of the country, and are conspicuous in the blooming season for their large, white, lily-like flowers, as well as for their long, sword-shaped leaves, terminating in a sharp point. There is no record to show that their fibers have ever been employed other than experimentally in this country, if we except the limited use made of the fiber by Indians and Mexicans of Arizona or Sonora, in the rude manufacture of cordage. There is one sample of rope in the museum, from New Mexico. It is fully half an inch in diameter, very rudely made, the fiber coarse and harsh, but of great strength. This sample, as well as fine specimens of the fiber from which it was prepared, was derived from *Y. baccata*. In Bernardin's list I find Yucca filamentosa is also called Henequen (Mexican name of *Agave Sisalana*), from which it may be inferred that the Yucca has been regarded to a certain extent a commercial fiber, probably exported with the Sisal fiber

under the one name Henequen,* as *Cannabis sativa* is sometimes exported from India with *Crotalaria juncea*, under the one name of Sunn.

The filaments of Yucca are white, brilliant, and stiff, composed of irregular bundles, the most of which are large. By rubbing briskly between the fingers the bundles break up into finer fibers, but always preserving a great deal of stiffness. The walls are usually thick, and the central cavity very apparent; the ends grow slender regularly, and are rounded at the extremity.

Yucca fiber possesses a moderate tenacity, but is somewhat brittle, and cannot be made to lose its harshness.

In the Australian collections (Exhibition of 1876) there are examples of *Y. aloifolia*, the Aloe-leaved Adam's Needle, prepared by Dr. Guilfoyle, who states that "though a native of South America, it succeeds admirably in Victoria, and is of moderately quick growth." He also calls it the Dagger plant. Dr. Guilfoyle sent a specimen of the *Y. filamentosa* ("The thready Adam's Needle"), which also thrives in Australia, where "its leaves are found rich in fiber and of good quality."

Little has been done in our own country in the way of manufacture. A machine has been invented, as will be seen by reference to part two of this report. Specimens of fiber recently submitted to the writer only prove what has often been asserted, that Yucca fiber is valuable and can be utilized for a variety of coarse uses.

Cordyline pumila.—The Dwarf Palm Lily.—Habitat, New Zealand. The fiber from this plant is another of Dr. Guilfoyle's preparations. The native name is *Ti-rauriki*. "The leaves of this interesting species of Cordyline grow to a great length and yield an abundance of fiber of long staple, suitable for ropes, mats," &c. It is also convertible into a good quality of paper. The fiber is from $2\frac{1}{2}$ to 3 feet in length, straight, white, and glossy, but very stiff, resembling fiber of Yucca or Agave, and seems to have been extracted in coarse bundles of filaments, which must be hackled to be reduced to anything like fineness. It is fully as strong as Yucca fiber, and would make excellent rope of great tenacity.

The plants of this genus are erect-stemmed, shrubby palm-like Liliaceæ, bearing spreading and very ornamental heads of elongate striated leaves. The species are found in tropical Africa, in Madagascar, and the Masiarine Islands, and in the Malay Archipelago. Two species at least are found in Australia and New Zealand, and all, doubtless, would produce excellent fiber. Fiber and tow from *Cordyline indivisa*, the tall "Palm Lily," were also received from the Victoria collection, prepared by Dr. Guilfoyle. They are not as fine as the preceding, however, though possessing considerable strength. A very rudely-manufactured rope from the last named species accompanies the collection. This fiber, however, is darker colored, and possesses little of the beauty of the preceding example, which has been carefully prepared. Neither Royle nor Vetillart make mention of this fiber, though it is named in Bernardin's catalogue.

Dracæna Draco.—Dragon's Blood Tree.—Habitat, Teneriffe. Grows also in Australia. Fiber of this plant was also received with the Victorian collection from the Melbourne Botanic Garden, where it is thoroughly established. Dr. Guilfoyle states that "the fiber is strong and flexible, but the tree is of very slow growth." It is prepared from the leaves, and is white, fine, and lustrous, and between 18 inches and 2

*Later I find that Vetillart, in speaking of *Yucca*, makes this statement: "It seems certain that in the cargoes of Pita which arrive at the markets of Europe there is found a proportion, more or less considerable, of Yucca fiber. It is difficult to distinguish the one from the other, and it is adaptable to the same uses." In this case it is exported with fiber of *Agave americana*.

feet in length. It is not as strong, however, as the Cordyline before mentioned, though it is much softer.

D. Draco "has a tree-like stem simple or divided at the top, and often, when old, becoming much more crowded, each branch terminated by a crowned head of lanceolate, linear, entire leaves of a glaucus green color, which embrace the stem at their base." The tree derives its name from a resinous secretion or exuduation known to commence as dragon's blood, which at one time formed an article of considerable export from the Canaries. Some of the plants are gigantic in size, "the colossal Dragon-tree at the town of Orotovia, in Teneriffe, being 75 feet high and 48 feet in circumference, with an antiquty which must at least be greater than the pyramids."

Dianelia latifolia.—A specimen of this fiber appears from Australia, where it was prepared by Dr. Guilfoyle. He states that the plant grows on the banks of creeks and fern-gullies in elevated situations, where its leaves sometimes attain a length of 6 feet. He considers the fiber good, and excellent for paper stock. The specimen still preserves much of its grass-like form, having been prepared experimentally in a simple manner. Some of the filaments are white and brilliant; it is quite strong, a few fibers twisted together requiring quite an effort to break them.

Its name does not appear in the list of useful textile fibers, from which it is to be inferred it has not hitherto been known as a fiber-producing plant of any value.

The plants of this genus are indigenous in Australia and tropical Asia. They have fibrous roots, grass-like leaves (from which the fiber is obtained), and paniculate-blue flowers. The plants bear many-seeded blue berries.

23.—JUNCACEÆ.

We now come to a group of plants producing fibrous material, but not fiber in the strictest sense of the word. The rushes and grasses, as a general rule, are used almost without preparation other than drying, the entire leaf of the plant entering into the composition of the manufactured article, which is coarsely woven, plaited, or braided into shoes, mats, baskets, &c., or twisted into a coarse kind of cordage. The "fiber" is sometimes extracted.

Juncus vaginatus.—The Sheathed Rush.—Two specimens of fiber from this rush were received from the Victorian collection, and are among the many fibers collected and prepared by Dr. Guilfoyle. The plant is a native of Victoria, and grows abundantly. It is regarded as a good fiber plant as well as an excellent paper stock, and the fiber is said to make a good substitute for human hair. It is a strong growing plant and is found extensively on the margins of lagoons and water-courses.

There are two farms of it in Victoria, one of which is much smaller than the other, and which is regarded as the best for fiber, while both are used for paper.

Rushes have been employed in one way or another for some of the purposes of other fiber, but they are generally employed for mechanical purposes only, as in the manufacture of mats, baskets, chair-seats, &c. *Juncus effusus* is cultivated in the province of Oomi in Japan for the manufacture of floor mats of the better quality. These are plaited very closely, the interstices filled with rice-straw, and are all of one size, namely, 3 by 6 feet, so that they can be moved from house to house. These mats are described as soft and elastic, and are often three or four

inches thick. For common matting, rice-straw is used, or other rushes, as *Scirpus lacustris*, *Hydropyrum latifolium*, &c., are employed, which grow everywhere.

The finer kinds of rushes (*J. effusus*) are sometimes bleached in the sun, which gives them a whitish instead of the usual yellow color. Of the same rushes a lighter matting is made which serves as blinds for windows, to protect from rain the thin transparent paper which answers for glass. The pith of rushes is sometimes used in making rush lights.

The fiber of the tall variety of Victoria (*J. vaginatus*) is sometimes over 2 feet in length, while that of the smaller one is 18 to 20 inches. In color it is a golden yellow. Under the magnifier the filaments are exceedingly irregular and rough, and are quite brittle. Twisted together into a thread they are as easily broken as Manila paper twine of the same thickness. Specimens of paper were also received, manufactured from both varieties, as well as from the "Coast Rush," *Juncus maritimus*.

Astelia Banksii.—This is a genus of sedge-like rushes found in the islands of the Southern Ocean. The plant is a native of New Zealand, and grows to a height of 4 feet. "It is rich in fiber suitable for ropes, paper," &c. The leaves of *A. alpina*, which grow on the sand-hills of the coast of Tasmania are edible. The fiber is of a dirty yellow color, the "filaments" exceedingly coarse and wiry; rather brittle when bent sharply, but of considerable strength when tested with a lateral strain. The specimen in the collection of the department was prepared by Dr. Guilfoyle.

24.—CYPERACEÆ.

Lepidosperma flexuosum.—The Slender Sword Rush.—Habitat, Victoria. A specimen of fiber from this species was received with the Australian collection. It is exceedingly brittle, and can only be used in mats or similar articles, where it can be coarsely plaited. According to Dr. Guilfoyle, the material can be had in large quantities, and is extensively used by the aborigines for baskets, mats, &c. He states that "under proper treatment it yields a fiber of good quality," though the present sample would hardly verify the statement. It, however, might be used in paper making, though at best is a poor "fiber."

Lepidosperma elatius.—The Tall Sword Grass.—This specimen shows a much better and stronger fiber than the preceding, and would prove useful for making many kinds of coarse cordage. The leaves and flower-stalks of the plant grow to a height of 9 feet in Victoria, and the plant is found in great abundance, and can be had in large quantities. It furnishes a pulp for paper-making, and is used in various ways by the natives. This specimen is also from the Victorian collection (Exhibition, 1876), and was prepared by Dr. Guilfoyle.

Cladium radula.—The Black Reed.—This specimen was prepared by Dr. Guilfoyle, who says: "This coarse-growing, sedge like grass can be had in enormous quantities throughout the colony (Victoria). It is extensively used by the settlers as a thatching material." It is a native of Australia. As a "fiber" it is of no value, as it has little strength. It is doubtful if it would make a good paper-stock.

25.—GRAMINEÆ.

Zea mays.—Indian Corn—Maize.—One of the most interesting exhibits in the fiber collection of the museum is a series of specimens illustrating the manufacture of corn-husks into a textile material. The

series includes husks, extracted fiber, spun fiber, or yarn, and specimens of well-bleached crash and oil-cloths. The specimens were received from the Austrian Government in 1863, together with a large series of papers made from the same material.

The first experiments in manufacturing paper from maize were made under the direction of a Bohemian named Moritz Diamant, at the Imperial paper-mill at Schlögelmuhl, near Gloggnitz. The experiments, however, were not satisfactory, as the endeavor to procure paper direct from the unwoven plant fiber was always met with great expense. The fact that cotton, flax, &c., were first woven and worn and then converted into paper, suggested the possible conversion of the new material into textiles first, and afterwards into paper. Thus the first process became last, and led to the production of a coarse cloth which is useful for forming the "body" of oil-cloths, as well as for a kind of toweling which will be useful only as it proves durable. The bleached specimens look well, however, and have a kind of softness, which, though several removes from linen, would recommend them for toweling of the coarser grades.

The paper samples appear in great variety, and many of them are fine and strong. (See the report of this department for 1863, pp. 436–438.)

Arundinaria tecta.—Southern Cane.—In the paper collection of the museum there are a number of specimens of paper made from a fiber produced from the southern cane by "steam-blowing," samples of the fiber being also exhibited. In reducing the cane to this fibrous state, tightly compressed bundles of the "bamboo" are placed in steam cylinders or guns 24 feet long and 12 inches in diameter, and there subjected to the action of steam at a pressure of about 170 pounds to the square inch for about ten minutes. "The gums and glutinous matters which hold the fibers together are thereby dissolved or softened, and while in that state the cane is blown into the air by the force of the steam in the gun, and the fibers are separated by the expansion of steam among them."

The papers exhibited are of different grades of wrapping-paper, "book," and "news" paper, some of the latter quite white and clear. It was claimed by the patentees of the process that good fiber could be furnished, from the gun, at $5 per ton.

The idea of utilizing so coarse a material for paper is not new. The Chinese have for ages used the bamboo for the purpose of paper-making, employing "shoots" one or two years old for the purpose. The system of reducing the bamboo is not so simple as the steam-blowing process employed with cane, for it necessitates macerating in water for a week or more, after which the pieces—some 5 feet in length—are washed and placed in a dry ditch and covered with slacked lime for a number of days, when they are again washed, cut into filaments, and then dried or bleached in the sun. In this state they are boiled in large kettles and subsequently reduced to pulp in wood mortars by means of heavy pestles. A glutinous substance is then mixed with the pulp, and upon this mixture the goodness of the paper depends.

Bamboo has been and is still used for paper-making in Japan, but only to a very small extent. The paper called *Chikushi*, notwithstanding that the translation of this word is "bamboo paper," is not made of bamboo; the name has only been borrowed from China.

While upon the subject of maize and cane paper it may be well to mention that quite an industry is carried on in the South by the manufacture of paper from "bagasse," or refuse sugar-cane as it comes from

the crushing mills, in Louisiana. (See closing portion of the second part of this report.)

Stipa tenacissima.—Mat Weed.—This plant, which is only interesting as furnishing a paper substance and not a textile, grows abundantly in Algeria and also in Southern Spain. With the Arabs it is called *Alfa*, the French call it *Sparte*, and the Spaniards *Esparto*, by which name it is commonly known in this country. It belongs to the grass family, growing in matted tufts, with long leaves; a bundle of Esparto grass, but for the color, resembling a corresponding mass of broom. Both in Africa and in Spain it is manufactured into sandals, hats, baskets, mats, ropes, sacks, nets, &c. The Spanish shepherds employ it in making hurdles for their sheep, and the Arabs use it in the manufacture of household utensils, weaving it so closely that liquid food can be carried in them. The young leaves are eaten by cattle.

The Esparto was introduced into this country over ten years ago. (See annual report of this department for 1868, p. 260.) In late years it has been exported in considerable quantities to France and England for the manufacture of fine paper, samples of which can be seen in the museum, together with the grass as imported.

Vetillart states that when the Esparto is reduced to a pulp and examined microscopically the fibers are seen to be "short, full, and smooth, and display a very fine central cavity. They are remarkable for their flexibility and tendency to curl up; they are sufficiently uniform, and the diameter is regular for a great part of its length. The points, which are rarely fine and sharp, are often rounded, sometimes truncated, bifurcated, or notched." The fiber separates easily.

Spartina cynosuroides.—Fresh Water Cord Grass.—This coarse grass grows to a height of from 2 to 6 feet, upon the margins of lakes and water-courses, in many parts of the United States. A few years ago it was successfully employed at Quincy, Ill., in the manufacture of paper, the source of supply being the Mississippi River, where it was found in vast quantities. It cost at the mill about $5 per ton, and made a very firm, better class of brown wrapping-paper—superior to straw—samples of which can be seen in the museum. The bruised stalks present quite a fibrous appearance.

26.—DICKSONIEÆ.

The fiber mentioned in this family belongs neither to the Endogens nor to the Exogens, but to a third group, known as Acrogens, or top-growers, which include the tree ferns.

Cibotium menziesii.—Tree Fern.—This plant is found in the Sandwich Islands, growing upon the high lands at an elevation of 1,000 feet, and produces a substance resembling silky hairs or down. It is called *Pulu*, and is used for upholstering purposes, and particularly for stuffing mattresses. It has become an article of export from the Sandwich Islands to the United States to the amount of several thousand pounds annually, the most of which, if not all, is consumed in California.

Pulu consists of "the hair-like scales found on the crown of the stem and about the base of the frond stalks of the ferns." One plant will furnish but two or three ounces, which requires four years to be produced.

Two other species, *C. glaucum* and *Chamissoi*, produce the "golden moss," as it is called by the Chinese, and a species of *Dicksonia* which grows in Madeira also yields a similar substance, which is used for the same purpose. It is also used medicinally as a styptic.

PART II.

OUR FLAX AND HEMP INDUSTRIES.

INQUIRY CONCERNING PRESENT PRODUCTION AND MANUFACTURE.

In connection with the foregoing report upon the vegetable fibers in the museum of the Department of Agriculture an obvious necessity appeared, a showing of the practical as well as technical and scientific sides of the subject, particularly in regard to fibers which are or may be grown within our own borders. With increase of population and wealth, and advance in art and culture, come new and ever-varying wants to be met, requiring diverse material in all modes of combination. Fabrics of strength superior to cotton, textiles of greater tenacity than wool, and textures surpassing either in cheapness, are the constantly-enlarging necessity of the times. With a present demand for 35,000,000 yards of bagging for cotton, while flax-fiber enough to produce it is thrown away, the effort to extend the production of flax bagging would seem to be worth official consideration.

The importation of products costing, with duties, $20,000,000 per annum, of which instead we should export at least an equal amount, is a feature in national economy not to be commended. We are introducing foreigners, hundreds of thousands per annum, and setting them to fruitless competition with the farmers in the production of wheat and cotton, cheapening our staple products, while we send abroad for our sugar, flax, hemp, jute, and many other necessaries suited to our soils and climate. It cannot be continued without serious injury to our agriculture. The present moment is not too early to call a halt in this wholesale importation of raw material. One good crop of wheat in Europe, with ours enlarged to 500,000,000 bushels, would depress prices and spread panic through the Northwest, which would give a new and terrible emphasis to the pressing need for diversification of our agricultural industry.

There is increase of flax for oil-making in the heart of the wheat-growing belt. Its rough straw is used in immense quantities for paper stock and largely for bagging. Jute can be grown throughout the cotton States, and there is no further doubt concerning the successful cultivation of ramie. Abuliton, the mallows, yuccas, and other fiber-bearing plants growing in wild profusion, invite wholesale utilization. With more invention, easily acquired skill in manipulation, and more method in cultivation, and care in preparation for market, great and permanent and ever-growing industries may be built up, providing labor for millions who need it, and increasing the present prosperity of the country.

In connection with the foregoing report, it was thought advisable, for greater completeness of the work in certain essential points, to issue a circular to manufacturers, asking information upon special subjects. Such a circular was prepared with a view of obtaining, first, statistics in relation to the fiber-manufacturing interest; secondly, to gain a knowledge of any recent experiments with new fibers that might prove worthy of cultivation; and, lastly, to learn as far as possible the present status of the flax and hemp industries, and what special encouragements are needed to further the production of these fibers in this country.

In January of the present year, copies of the circular were sent to flax, hemp, jute, and other manufacturers of vegetable fiber (with the

exception of cotton), and to such other persons as are interested in the furtherance of American textile industries. At the same time efforts were made by special correspondence and inquiry to secure the latest and freshest information regarding such plants as ramie, abutilon, the mallows, yucca, and others, which are susceptible of cultivation, yielding fibers worthy of utilization in the arts. The subject of new machinery has also been considered, especially in relation to those fibers which, produced as yet only experimentally, have been awaiting a cheap means of mechanical manipulation.

The following is the text of the circular issued:

UNITED STATES DEPARTMENT OF AGRICULTURE,
Washington, D. C., January 1, 1880.

DEAR SIR: A report upon 115 species of vegetable fibers, recently prepared by Mr. Charles R. Dodge, of New York City, is ready for publication; but it has been thought advisable, in view of the rapid advancement of the jute, flax, and hemp industries, and of the growing interest in ramie or China grass, to add a chapter, before publication, bearing particularly upon the fibers named, with the latest information, statistics, &c., concerning their production and manufacture. It is my desire that this report be as complete as possible in its economic and practical features, and, describing as it does many new or little-known fibers as well as those of fixed commercial value, with their uses, growth, preparation, &c., to make it of special value alike to producer and manufacturer.

For the purpose of gaining correct information as to the manufacture of the fibers named, and a knowledge of other fibers that may possibly be utilized to a very limited extent, this circular has been prepared, and the appended list of questions submitted to manufacturers for reply.

As the department is particularly interested in encouraging home production, and of advancing the cultivation of new or partially-tried fibers that may prove *worthy* of more general use, it is of special importance to discriminate between native and imported fiber. If you have had experience with other vegetable fibers than those named in the circular (excepting cotton), experimentally or otherwise, any information that can be given the department concerning them will be thankfully received, and credit given in the report. The replies to this circular will only be used in preparing a summary of results, which will interest none more than the manufacturers themselves, and will be confidential as far as it relates to the private business of individuals, and known only to the compiler.

Any envelope samples of manufactures or of fibers sent to Mr. Dodge will be subsequently exhibited in the museum of the department, credited to the donors upon the regular museum labels.

Please reply at an *early date*, using the inclosed return envelope.

I am, respectfully,

W. G. LEDUC,
Commissioner of Agriculture.

QUESTIONS.

1. Name of fiber manufactured by you.
2. Source of supply.
3. In what form received.
4. Quantity used per annum; *a* imported, *b* native.
5. Price per pound as received at the manufactory.
6. Do you make a difference in price between the imported and native; and why?
7. What class of goods do you manufacture? Uses of such goods?
8. Can you give a general statement of the amount of each kind manufactured in 1879?
9. What new machinery or processes have recently been introduced?
10. Principal market for goods?
11. How does the native-grown fiber compare with that which is imported?
12. What experience have you had with ramie or China grass?
13. Have you ever tested or manufactured other vegetable fibers of native growth, as asclepias, abutilon, the mallows, &c., or any of the tropical foliacious fibers, as yucca, agave (Sisal hemp), or other fibers, and with what results?
14. Give views of special encouragements or hindrances affecting the extension of such manufactures.

At the outset of the inquiry it was proposed to incorporate the general results of the investigation in the main report on the fibers of the museum collection (Part I), and to treat each plant under its respect-

ive title and in its appropriate place. This plan has been carried out with fibers of whose growth and manufacture we possess only experimental knowledge, and also with flax, hemp, and jute, in matters of general information, history, &c. The economic considerations, questions of production, supply, manufacture, and tariff relations of the three named fibers, however, are so intimately related and their interests so connected, I have concluded to treat them conjointly in this chapter, forming Part II of the fiber report. The best methods of cultivation and preparation, particularly of flax, have been presented, and a portion of the report devoted to ramie and other fibers with which practical results have been accomplished. The report is presented in the hope that our farmers may become more intimately acquainted with these great sources of national wealth, and do their share towards making fiber production in this country an assured success.

PRODUCTION.

It has been stated that next to wool in the fiber production of the United States flax stands third on the list. In 1850 the product of raw flax for the whole country amounted to 7,709,676 pounds, falling in 1860 to 4,720,145 pounds, while, according to the census of 1870, there was a product of 27,133,034 pounds. Of this quantity over 87 per cent. was grown in the three States of Ohio, New York, and Illinois, Ohio alone producing over 17,000,000 pounds. In order of quantity New York and Illinois come next, with something over 3,000,000 and 2,000,000 pounds respectively. These States are followed by Pennsylvania, Iowa, Wisconsin, Michigan, Kentucky, and New Jersey, all producing above a quarter of a million pounds, Pennsylvania and Iowa together producing 1,500,000 pounds. It is difficult to estimate the present area in flax, but it cannot fall much below 400,000 acres. There has been a decrease in acreage in some of the easterly States, but this is more than compensated in States lying west of the Mississippi, formerly producing comparatively little.

The five States of Ohio, Indiana, Wisconsin, and Kansas had a little more than 150,000 acres under flax cultivation in 1869, and about 250,000 acres in 1877–'78. Ohio produced in 1869 17,890,624 pounds of fiber, and in 1877–'78 but 7,313,294 pounds, a tremendous falling off. I cannot find satisfactory reports of amount of lint produced in other States for the last-named date, but the seed figures show an enormous increase in cultivation in Western States, especially Kansas and Iowa. In 1869 Kansas produced but 1,553 bushels of seed and Iowa 88,621 bushels. In 1877–'78 the production of the same States amounted to 291,309 bushels and 529,878 bushels of seed respectively. The census of 1880 will show still larger figures. Hemp cultivation has for the most part been confined to Kentucky and Missouri, other States producing it only in very limited quantities. As long ago as 1842 the production of Kentucky amounted to 15,500 tons. The following table gives the production of five States since the year 1850:

Hemp production.

States.	1850.	1860.	1870.
	Tons.	*Tons.*	*Tons.*
Kentucky	17,787	35,065	7,777
Missouri	16,028	17,295	2,816
Tennessee	595	1,040	1,033
Pennsylvania	44	43	571
Illinois	....	294	174

This shows an increase in the first decade—the production being doubled in Kentucky—and a very great decline in the second. The coming census will no doubt change these figures materially as the product of Kentucky has only slightly increased since 1870, varying from 7,000 to 8,000, while in some other States there has been a decided increase. With hemp production, hemp manufacture has also declined greatly in Kentucky since the last census reports were made. Major Proctor of the State survey is of opinion that not more than 2,500 tons of hemp tow are now used in the manufacture of cordage, twine, and bagging, in the State. He gives as the several causes for the decline in cordage manufacture the introduction of manila fiber, the decrease in American ship-building, and the introduction of improved machinery in the East. "The extent of the change wrought by the introduction of improved methods is shown in the fact that in 1840, 4,464 operatives produced $4,078,306 worth of cordage, and in 1870, 3,698 operatives produced $8,979,382 worth of cordage."

FOREIGN SUPPLY.

The imports of flax and hemp, raw and manufactured, during the year 1879 amount to $5,781,710, and of this amount, $2,798,465 was paid for the raw material in the ratio of one to two, flax being the lesser import.

For the foreign flax supply we depend mainly upon six or seven countries, and in the last ten years but fifteen countries are represented in all, only eight furnishing a steady supply. Since 1877, inclusive, Russia has furnished the largest amount and England next, the last-named country leading in the seven years previous. A considerable amount comes from Canada, either in the form of tow or line. The tow being subject to a duty of $10 a ton when intended for bagging manufacture, though it comes in free for paper-stock. The Boston market is largely supplied from Archangel, either direct or via England, though a large quantity of this fiber also comes to the port of New York. Holland flax is used to some extent, though it is not in such demand as formerly. At one time it was considered the most perfectly prepared flax in the market, being even at the ends well cleaned and strong. Rotterdam and Zealand flax is imported in small quantities, and Belgium sends us small amounts, varying in the ten years from five to seventy-five tons. But ten tons were reported for the year 1879.

It is difficult to get at the true figures as regards any one market, on account of the increased amount of indirect importation in small quantities. Messrs. R. B. Storer & Co., Boston, estimate the quantity of flax—hackled and line—and also of tow received in that market during the year 1879 to be 3,730,000 pounds. By far the largest portion, or 3,583,400 pounds, was received from Russia, and of this quantity 1,405,300 pounds was imported in the form of tow. The small balance was received chiefly from Ireland and the Netherlands, there being 59,500 pounds from the former country and 87,100 pounds from the latter. Very little line or dressed flax was imported last year, nearly all of it being hackled or undressed, and flax in this condition of a superior quality is imported at a slight duty because a partial manufacture.

In 1879 the flax importation into New York, as per figures furnished by Barbour Brothers, amounted to 1,420 tons, or 3,180,800 pounds; 970 tons of this was flax costing from $300 to $550 per ton, leaving 450 tons of tow valued at $225 per ton, a total valuation of flax and tow to the amount of $600,000.

Referring to the customs figures we find that for the year ending June 30, 1879, there were 2,935 tons of raw flax fiber, including tow, imported from seven countries, at a cost of $969,451, a falling off from the previous year of $207,778, and a smaller amount than in any year since 1870, when the raw flax imports were 100 tons less.

The following table of quantities and values shows the sources of foreign flax supply for the last ten years.

Countries.	1870.		1871.		1872.		1873.		1874.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
Belgium	5	$443	......	....	75	$33,761	35	$14,486	9	$3,112
Germany	9	1,812	5	$1,682	4	1,344	54	12,342	13	2,463
England	524	245,106	1,579	337,608	1,730	506,075	817	385,963	1,094	418,192
Scotland	99	36,284	87	28,509	674	208,082	278	98,534	311	107,345
Ireland	......	....	......	....	......	....	......	....	......	....
Canada, &c.	493	82,961	1,128	159,323	638	152,690	558	139,206	854	153,184
British Australasia	9	1,123	430	52,186	398	44,634	972	104,129	393	43,070
Netherlands	129	61,077	51	22,888	237	98,197	217	76,610	258	93,995
Russia	649	175,137	360	87,224	1,517	354,489	1,236	305,178	489	119,659
Other countries	10	2,019	32	5,412	1	475	7	1,289	5	718
Total	1,927	605,962	3,672	694,832	5,274	1,399,747	4,171	1,137,737	3,426	942,038

Countries.	1875.		1876.		1877.		1878.		1879.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
Belgium	27	$9,121	18	$8,667	44	$19,458	59	$26,127	10	$3,787
Germany	1	237	......	44	......	....	......	....	......	....
England	609	283,331	555	310,043	747	310,519	234	108,171	613	193,051
Scotland	730	264,173	339	162,743	250	116,782	217	76,220	364	167,816
Ireland	69	30,378	14	9,539	228	132,917	542	322,510	299	169,220
Canada, &c	1,403	195,493	1,540	272,628	1,635	238,908	1,275	175,121	458	84,459
British Australasia	139	12,419	......	....	7	730	11	970	......	....
Netherlands	189	63,568	148	47,772	128	38,573	49	18,272	35	12,661
Russia	1,155	253,685	1,037	246,769	1,459	385,177	1,628	449,838	1,156	338,457
Other countries	......	....	8	2,232	......	....	......	....	......	....
Total	4,322	1,112,405	3,659	1,060,437	4,448	1,243,064	4,045	1,177,229	2,935	969,451

The finest foreign hemp, and that which brings the highest price, comes from Italy, this little kingdom producing over 90,000 tons annually, the yearly production of the United States not being over 20,000 tons. The principal foreign supply of hemp, however, is derived from Russia, and in the past year large quantities have been imported, owing to the insufficiency of the American supply.

Mr. Joseph Chisholm, of Salem, Mass., states that there are three grades or selections of St. Petersburg hemp for general importation, the clean, outshut, and half clean, the first being the best, the second that which is rejected upon government inspection, and the third the lowest and poorest grade. "The cleaned was that of which stays and shrouds for ships, &c., used to be selected," because of its less elasticity. Archangel hemp is shorter than the St. Petersburg, showing the effect of high latitude on length of staple. Of other Russian hemps may be mentioned the Riga, which is also shorter than St. Petersburg, and the Polish, which is an excellent hemp. Russia exported to the United States in 1879 but 53 tons of the different grades, and in 1878 but 49 tons, valued at $6,788. In 1878, Great Britain imported from Russia 287,678 cwt. of all kinds, at a total valuation of $2,389,830 in American money.

The following table of hemp importation shows the source of foreign supply in the last three years:

Hemp imports for three years, ending June 30, of each year.

Countries.	1877.		1878.		1879.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
China	471	[illegible]	449	[illegible]	1,036	$101,965
Hong-Kong	61	6,840	....	....	566	62,146
England	240	51,390	494	98,871	573	90,244
Scotland	3	1,164	1	378	4	1,011
Ireland	5	2,157	5	1,557	14	4,225
Canada	....	....	1	119	....	....
Italy	47	12,517	21	5,734	170	33,327
Japan	....	....	1	232	....	....
Mexico	275	24,[illegible]	79	8,870	495	44,657
Russia	....	....	40	6,788	53	9,803
Spanish Possessions	15,813	1,[illegible]	19,[illegible]	2,047,147	14,587	1,459,810
Germany	211	39,331	27	3,292	....	....
British West Indies and British Honduras	2	21	....	....	....	....
British Possessions in Africa	....	....	....	....	186	18,534
Total	17,12[illegible]	1,8[illegible],460	20,503	2,221,164	17,711	1,829,008

It is not easy to get at the exact amount of "Russia hemp" imported, as the table also includes the various other "hemps," as Manila, Sunn, Sisal, &c. The trade name "Russia hemp" has been applied to *Cannabis sativa*, to distinguish it from other hemps derived from foliaceous plants. Such hemps will be received from the Spanish possessions (Philippine Islands), Mexico, &c. Much of the hemp credited to England in the above table has doubtless been imported from Russia into that country, and re-exported to the United States. A large quantity of the flax supply comes to us by indirect importation, and principally through England.

The importation of India jute fiber, jute butts, and jute yarn, for the year ending June 30, 1879, amounted to $2,873,202. Of this amount, $662,930 was for jute fiber,* and $1,702,257 was for jute yarn. This represents, in round numbers, 19,000,000 pounds of jute, 97,500,000 pounds of jute butts and rejections, and 2,000,000 pounds of jute yarn. This does not include the imports of foreign gunny-cloth.

Imports of flax and its manufactures into the United States from 1870 to 1879, inclusive.

Years.	Flax, raw.		Manufactures.	
			In yards.	Other manufactures.
	Tons.	Dollars.	Dollars.	Dollars.
1870	1,927	605,962	12,716,656	3,536,506
1871	3,672	694,832	13,569,702	4,509,393
1872	5,274	1,399,747	16,615,066	4,605,430
1873	4,171	1,137,737	16,271,590	4,156,801
1874	3,426	942,038	14,081,428	3,391,327
1875	4,322	1,112,405	14,124,947	2,478,295
1876	3,659	1,060,437	12,237,936	2,218,110
1877	4,498	1,243,064	11,509,894	2,406,003
1878	4,045	1,177,229	11,490,758	2,922,842
1879	2,935	969,451	11,817,647	2,876,190

* Sunn hemp is also included, a comparatively small quantity of this fiber entering the market, principally used for inferior kinds of rope and cordage.

Exports of flax and its manufactures from the United States.

FOREIGN OR RE-EXPORT.

1870	....	....	13, 602	121, 970
1871	34	4, 957	8, 092	160, 011
1872	85	11, 598	24, 276	108, 024
1873	45	5, [illegible]	8, [illegible]	175, [illegible]
1874	8	755	5, 571	164, 861
1875	48	6, 535	75, 319	117, 070
1876	15	1, 415	31, 487	73, 952
1877	....	....	61, 822	64, 284
1878	....	....	4, 509	98, 305
1879	....	....	65, 934	64, 282

Imports and exports of "Russian," Manila, Sisal, and other hemps and their manufactures, from 1870 to 1879 inclusive.

IMPORTS.

Years.	Raw.		Manufactures.		Other manufactures.
	Tons.	*Dollars.*	*Sq. yards.*	*Dollars.*	*Dollars.*
1870	22, 557	4, 060, 378	785, 467	124, 535	258, 480
1871	20, 805	3, 918, 129	931, 658	135, 823	287, 596
1872	27, 613	4, 580, 049	526, 793	90, 850	366, 891
1873	20, 573	3, 347, 973	212, 651	40, 414	231, 707
1874	24, 325	3, 676, 967	75, 301	12, 152	102, 032
1875	23, 063	3, 110, 303	124, 986	10, 277	98, 805
1876	17, 979	2, 247, 540	4, 687	774	79, 860
1877	17, 128	1, 852, 480	27, 342	7, 404	91, 593
1878	20, 503	2, 221, 164	9, 562	2, 232	90, 894
1879	17, 711	1, 829, 008	30, 645	9, 061	98, 600

FOREIGN EXPORTS.

Years.	Raw.		Manufactures.		Other manufactures.
	Tons.	*Dollars.*	*Sq. yards.*	*Dollars.*	*Dollars.*
1870	515	96, 525	794	270	5, 852
1871	1, 325	[illegible]	....	....	1, 109
1872	978	173, 056	....	....	1, 663
1873	1, 230	224, 544	....	....	1, 923
1874	1, 280	213, 741	....	....	1, 646
1875	999	156, 024	....	....	3, 500
1876	1, 525	196, 912	....	....	797
1877	1, 590	200, 757	....	....	9, 705
1878	915	108, 294	....	....	239
1879	889	106, 667	....	....	....

DOMESTIC EXPORTS.

Years.	Hemp manufactures.		Cables and cordage.		All other manufactures.
	Cwts.	*Dollars.*	*Cwts.*	*Dollars.*	*Dollars.*
1870	4, 240	45, 260	9, 997	218, 496	67, 035
1871	573	5, 775	10, 207	190, 946	85, 066
1872	561	7, 103	9, 918	195, 901	114, 869
1873	978	9, 121	14, 960	275, 160	170, 725
1874	1, 106	8, 901	16, 239	272, 612	861, 746
1875	2, 140	21, 856	11, 133	171, 196	706, 309
1876	870	8, 318	11, 200	147, 009	737, 042
1877	1, 467	12, 182	13, 072	175, 750	695, 625
1878	2, 325	18, 210	11, 402	146, 043	1, 056, 709
1879	1, 281	8, 155	16, 182	170, 179	1, 153, 471

Jute, cocoa, and other fibers and manufactures of, imported and exported from 1870 to 1879 inclusive.

IMPORTS.

Years.	Raw.		Manufactures.				
			By yards.		Gunny-cloth, bags and bagging.		Other manufactures.
	Tons.	*Dollars.*	*Sq. yards.*	*Dollars.*	*Pounds.*	*Dollars.*	*Dollars.*
1870	19,049	1,376,762	4,565,827	423,166	8,781,753	291,218	1,064,131
1871	26,450	2,131,056	228,873	28,556	30,124,466	1,468,902	1,734,474
1872	41,851	2,666,479	185,257	24,260	12,137,603	505,556	1,292,515
1873	27,969	1,967,971	89,102	16,690	9,569,503	404,851	2,054,430
1874	9,799	1,006,618	6,411	1,462	6,391,413	341,148	1,966,057
1875	21,852	1,273,034	10,843	1,772	3,907,915	209,622	2,397,840
1876	60,363	2,384,881	2,634	626	3,700,957	197,016	1,363,095
1877	50,793	2,351,778	1,191	629	3,248,465	162,286	2,213,694
1878	40,997	2,438,198	162	114	2,864,450	155,646	1,510,630
1879	69,590	3,781,037	2,236	860	2,856,195	146,660	1,629,750

EXPORTS.

Years.	Tons.	Dollars.	Sq. yards.	Dollars.	Pounds.	Dollars.	Dollars.
1870	673	88,316	....	....	361,777	13,332	19,702
1871	135	13,630	....	....	14,585	623	15,223
1872	157	24,636	4,620	1,191	654,139	34,929	13,644
1873	734	53,143	1,698	122	987,737	61,263	20,869
1874	159	18,262	40	10	1,501,325	70,913	33,842
1875	307	35,422	....	....	684,531	23,901	22,381
1876	1,181	125,102	....	....	408,099	18,422	20,888
1877	984	97,470	....	....	....	....	39,218
1878	1,168	116,136	....	....	23,000	959	19,235
1879	812	76,508	....	....	....	....	32,709

By reference to the table of flax imports it will be seen that there was a considerable falling off in amount of flax imported in 1879 (year ending June 30), compared with the previous year. Messrs. R. B. Storer & Co. account for this from the fact that we were at that time in the depth of depression in the linen interest, and manufacturers only imported enough raw material to keep the works from coming to a standstill. Foreign and domestic flax was lower than it has been known for a quarter of a century, and Scotch spinners, in order to find an outlet for their goods, sent large amounts by steamer for auction sale in our markets.

It is said there will be a large importation the present year, both on account of the peculiar qualities of the foreign fibers and because of the small supply and poor quality of American flax of the last season.

QUALITY.

The question of quality, especially in regard to flax, is one of the most important considerations in the fiber industry. The ability to produce fiber to any required amount within our own borders is of less moment than the ability to produce a *quality* of fiber that will compete with that produced in the flax-growing countries of Europe. It is grown to an exceedingly limited extent in this country for *fine* fiber, though there are large areas under cultivation in the Middle and Western States chiefly for the seed. For this purpose it is grown until thoroughly ripened, cut with a reaping-machine, thrashed upon a common wheat-thrasher—there being nothing yet invented to keep it straight—and the straw sold by the load at the nearest mill. It is transported like hay, in a tangled

bulk of fiber, pitched upon the load loosely just as it comes. In some sections it cannot be sold at any price, and in such a case is often burned to get rid of it.

There is necessity for greater care and skill in the American production to obtain a finer material, more strength by improved methods of treatment, and more evenness in length. The Irish and Dutch sow thick for fine fiber. They have a moist climate, too, which gives better fiber, although in Northern New York, and New England, Michigan, Oregon, &c., the latter especially, fine flax can be grown. Farther south, under a hotter sun, the climate is drier, and therefore not so favorable for the production of fine fiber. The principal reason for coarseness, however, is the production for seed, as has been stated. It is sowed thin and not cut until fully ripe. The stalks are large and coarse, and the fiber good for nothing but as a substitute for jute butts in the manufacture of bagging, or tow for paper stock.

I am informed that flax was sent to market from Connecticut sixty years ago that was strong, clean, and as good as any raised in the United States at the present time. Very strong and flexible flax also came from Northern New York and Vermont, but it was not clean. The meanest flax of those days came from New Jersey, though the State is capable of growing flax now equal to Archangel flax. What is termed North River flax at this day, found in the New York market, is strong, but poorly cleaned.

Different grades of flax are used by the various manufacturers, dependent upon the kind of goods produced. For the finer classes of goods foreign fiber is principally used, though the American is utilized to a greater or less extent in all manufactures. Goods produced from foreign flax are said to be in every way superior, and, of course, command the highest prices. A Massachusetts manufacturer of crashes and similar grades of linen goods, using flax from Northern New York, Canada, and Russia, makes a difference of one-half cent in favor of American flax if well dressed, because the fiber is better than the grade of Russian used. Another eastern manufacturer considers best American flax about equal to the third crown Archangel flax, and states that this grade is less called for when American is abundant and of reasonable price. The Russian flax possesses a great advantage over the American, apart from its quality, in its regular and uniform preparation for market. The various grades are fixed by a government standard, and before any fiber is sent abroad it must be examined and graded by officials appointed for the purpose. Manufacturers, therefore, receive a flax year after year of about uniform length and color, varying in strength only as the crop varies from one season to another. From want of experience and united action on the part of our growers, as well as from the uncertain element of labor, American flax is seldom prepared twice alike, and the manufacturer cannot tell what he is buying without first making tests with small samples. The difficulty is increased with the number of sellers, as no two seem to seek the same standard. Concerted action on the part of both buyers and sellers would tend to diminish the difficulty, and with more certain preparation of domestic fiber will come an increasing demand.

In the manufacture of thread requiring the use of fine flax, the imported is generally preferred and costs about one-third more than the native. Some of the eastern spinners say the native does not operate smoothly enough to make fine work, and the color is not desirable. The bad color is easily accounted for through careless rotting. On the other hand for coarse uses, as in the manufacture of bagging, it is held that

native flax tow is the best, though there is less competition in this form of flax than any other. Canada flax by some manufacturers is considered finer and softer than much of the American, but even here there is room for improvement in growing, and in manipulation.

It is claimed that the only foreign hemp which comes into direct competition with American is that imported from Russia. American hemp possesses greater flexibility than Russian, though the latter is of more equal length, as has been explained, and through its less flexibility is preferred for stays and shrouds. On the contrary, Russian hemp cannot be dressed so fine as the American, and on account of the greater cheapness of the latter, with equal strength, the Russian has been nearly driven from the market. Boulogne or Italian hemp has also great flexibility with great strength, though coarser and inferior qualities of this hemp find their way to our market. Owing to the present scarcity of the American product manufacturers have been importing largely from Russia again. There is a consequent demand for Kentucky hemp, and it is stated that a much larger area has been planted than in many previous years. Large contracts are said to have been made for the crop of 1880 at $5 per 112 pounds. Seed was purchased at $3 per bushel and even higher, and land rented at $10 to $12 per acre. With a very large crop prices may be depressed and some hemp cultivators may not realize all their hopes, though the quality of American hemp has been so greatly improved in late years by better methods of softening the fiber, and through improved processes in spinning, that it will take a higher grade of manufacture, and new sources of demand will be created. Fine-dressed American hemp is too good for standing rigging of vessels, and can be better employed than in the manufacture of bagging. It is very fortunate at this time for the fiber industry that twine binding is coming into vogue in the grain fields, in place of wire binding, to which there have been serious objections. Enormous quantities of twine will be required by the grain-binders, either of flax or hemp, and doubtless the new industry will open many mills throughout the West and Northwest.

PRICES.

Price is such a relative thing, it is impossible to give figures in a report of this nature that can be quoted at the time of publication. So much depends upon the state of the market, with changes in the domestic and foreign supply, that the price of a product can only be given in general terms. A majority of the replies to the circular were received in February of the present year (1880), and the quotations may be understood to apply to that time. In the case of hemp, however, at the date specified, the American supply was short, there was a demand upon the foreign markets, and for a time everything was so unsettled, quotations could only be given from day to day. During March American hemp rose in price perceptibly, and is now somewhat higher than the following quotations given as the ruling prices in New York on the 8th of January: Undressed American hemp, $140 per ton; single dressed, $185 to $190 per ton; double dressed, $205 to $210 per ton; Russian hemp held at $265 per ton for the best Riga; best Italian, $300 per ton; medium, $200, and inferior, $175 per ton, all of 2,240 pounds. Water-rotted Italian hemp sells in New York for about twice the price of dew-rotted Kentucky hemp.

Regarding the home market for Kentucky hemp, I can only give figures from the Lexington Gazette of about the 1st of March, where the statement is made that the produce of 300 acres had been bought at $6

per 112 pounds, the manufacturer offering $7 per 112 pounds for the crop of 1878, with a premium of $50 in addition to the $7. No special reason is given for this advance, unless it be the demand for twine from grain-binders, to which reference has been made.

Eastern manufacturers were paying for American double-dressed hemp, $210 to $230 per ton, about the middle of February, and for best Italian, $300. On the 22d of March the prices of Kentucky hemp had advanced to 14 cents per pound on single dressed, and to 16 cents per pound for double dressed, $313 to $350 per ton, with prospect of a greater rise.

About the middle of February, of the present year, dressed flax was quoted at 13 to 15 cents per pound, and broken and scutched flax, about the same time, 11 cents per pound. In 1863 dressed flax averaged 28 cents per pound, from that price down to 15 cents in 1870, and 10 cents in 1879. The flax mills in the interior are mostly engaged in manufacturing tow, the supply of rough flax coming from the country contiguous to the mills or within a radius of 12 to 15 miles. It is made from rotted straw, grown mostly for the seed, and is worth as it comes from the thrashing machine about $3 to $7 per ton, delivered at the mill. Much of this is used for paper stock and for bagging, bringing about $10 per ton. Upholsters' stock from green straw is worth $35 per ton; that used for crash and twine is worth $100 per ton, delivered in New York and Boston. Russian flax tow is quoted at the present writing at about $200 per ton.

The following tables, prepared by Mr. Proctor, give minimum and maximum prices of hemp and flax for twelve months of each year from 1864 to 1873. It will be seen that the price of Russian hemp has declined more than that of American:

Years.	American dressed hemp.		American undressed hemp.		Russian hemp.		American flax.	
	Lowest per ton.	Highest per ton.	Lowest per ton.	Highest per ton.	Lowest per ton.	Highest per ton.	Lowest per pound.	Highest per pound.
1864	$250	$350	$140	$225	$400	$600	$0 16	$0 30
1865	255	350	120	240	350	600	11½	28
1866	310	390	220	300	340	385	17	25½
1867	310	385	230	290	345	375	16	23
1868	270	400	160	240	240	360	15	24
1869	270	335	175	215	240	360	16	24
1870	250	320	180	215	240	250	12	21
1871	255	285	160	190	200	240	12½	19
1872	190	275	120	160	200	225	15	18
1873	175	240	115	130	210	225	15	19

The price of jute and jute butts is materially higher than during the previous year. The prices quoted in returns from the circulars show that prices range from 3 to 5½ cents per pound.

COMPETITION.

One of the large New York manufacturing firms state in their reply to the circular that Kentucky and Missouri hemp, being used only in the manufacture of tarred standing rigging for vessels, small lines, twines, &c., does not come in competition with any foreign hemp except Russian, which is used for the same purposes. American hemp has been the cheaper of the two, however, and has driven the foreign product out of the market to a great extent. Much of this quality of hemp is

simply dew-retted, as it answers equally well for cordage, &c., as the water-retted, with the advantage of saving the extra trouble and expense of the last-named process. The fine Italian hemp is used principally for spinning into yarns, carpet, warps, fine twines, &c., and now that American hemp is beginning to be in demand for spinning purposes a carefully water-retted article of home production will come into competition with it. To compete successfully with it, however, farmers will have to learn something of foreign methods of cultivation and treatment of the fiber; in other words, they will be called upon to compete with foreign skill and experience.

The same may be said of flax-culture; in fact it is the principal drawback to successful cultivation. It is in one sense a trade that is to be thoroughly learned and followed after it is acquired, and it is only by long practice and experience that foreign flax-growers are enabled to produce a uniform fiber upon which reliance can be placed. It is too much the practice of American farmers to dive into the latest sensation hap-hazard, trusting to luck and good prices—ready to leave it as quickly for the next golden promise, be it beet-sugar culture or wool-growing. It is not to be understood that the farmer must grow flax or hemp, and these products only, but he must stick to the cultivation of a certain amount—if he wishes to grow it at all—year by year gaining new experience and skill, which will insure better prices as he produces a better article, enabling him finally to compete with European cultivators, climatic conditions being equal. Thus a steady supply will be created, which, in the long run, will be productive of an established industry and prove a source of wealth to the country. The Russian flax will always hold a slight advantage through its grades being fixed by government standards. A uniform American standard could easily be established, however, if those interested in the home flax trade would take united action in the matter. In all probability increased production would make it a necessity.

The special hinderances to the flax industry in this country are thus summed up by a manufacturer in the interior of New York State:

> Low duties on the imported articles; the extensive cultivation of flax in Canada; the hap-hazard and wasteful manner of cultivation and handling here; not being able to compete with foreigners in cheapness of labor, nor in quality and value of the article. In fact the price has been so low for the past five years, and there is so much labor and expense attending it, that it has not paid the grower his expenses.

At first glance it would appear from the above that flax-culture in this country was in a truly lamentable condition, and that there was nothing left for American farmers to do but to accept the inevitable and let flax severely alone. A little tariff legislation in favor of home production might better things somewhat, though it would be folly to put on the screws to any great extent before there was a prospect of a home supply. The "hap-hazard and wasteful manner of cultivation" complained of must be abandoned for better methods, thereby raising the "quality and value of the article," and paving the way for competition with other countries. With new and improved machinery the labor and expense of preparation may be lessened, and, taken altogether, there is certainly a bright side to the picture. A lesson may also be learned from a perusal of the following extract from Mr. Proctor's letter, to which reference has already been made. He says:

> I believe there is a great future for the hemp industry in Kentucky, and the demand for Kentucky hemp will steadily increase until it is as great or greater than in past years; but the demand will require hemp more carefully prepared. Formerly the demand was for cordage and bagging. In the future, in addition to the require-

ments for those articles, there will be a large and increasing demand for spinning into yarns, for fine twines for binding grain, and I believe also for crash towelings and fabrics of various kinds. The agriculturist who anticipates the demand by growing the finer qualities of hemp, and preparing it with care for market, can *command* a remunerative price for this product.

To return to flax again, it is worth while to encourage its cultivation from its competition with other crops. If there are 400,000 acres in flax, if it were put in wheat instead, it would yield five to six million bushels and aid in reducing the price of wheat. If not in flax it would compete with the staple products and reduce the price of them. The seed produced in the five states of Ohio, Indiana, Wisconsin, Iowa, and Kansas in 1869 was about a million and a quarter bushels. It is probable that the amount of seed produced in 1878 was not far from three millions in all.

While touching upon the wheat question, let me digress a little: It has been the study of political economists and protectionists for long years how to frame tariff laws to enable successful competition with the Old World, and now we are confronted with the spectacle of a people forced to compete with themselves, or to put it more plainly, the older sections of the country are *unable* to compete with other sections where farming is conducted upon high-pressure principles. The Western capitalist, with his broad acres stretching away to the sunset, with his gang-plows, headers, and steam-thrashers, is enabled to grow wheat and make money out of it at prices which are discouraging to the Eastern agriculturist, or even the Western small farmer. We cannot all grow wheat. Sheep and cattle even can be more profitably produced in the fertile valleys of the far West, and a "diversified agriculture," with too many farmers, means growing what everybody else is growing at bottom prices. But diversified agriculture should mean something else. Beet-sugar and corn or sorghum sugar are no less elements of national wealth because furnishing a home supply of a product that would otherwise have to be imported, than are flax, hemp, or ramie even. Fiber cultivation has perhaps a greater claim, because it is not a new industry, or a foreign industry to be introduced into the country. It is an industry native to the soil, so to speak, that has only languished from neglect, a neglect that perhaps the national government is to a certain degree responsible.

If the eastern and middle sections of the country cannot compete with the large wheat farmers of the far West in producing grain, they can at least do something towards preventing importation of vegetable fiber by turning their attention to the fiber industries. Western farmers owe a fair share of their success to improved machinery, and it is through improved machinery and new processes—turning the corners more sharply with their eyes wide open—that our Eastern farmers will be enabled to produce textile products that shall in time drive foreign fiber from our markets.

MANUFACTURE.

Mr. Gary, of Dayton, Ohio, a flax manufacturer, estimates that at present, in the West and Northwest, there are 100 flax-mills, producing on an average 300 tons of tow of all grades. He estimates three-tenths for upholstering, four-tenths for paper stock, and three-tenths for bagging. One hundred mills, producing an average of 300 tons each, would give, in round numbers, 30,000 tons as the total flax manufacture of the West. According to the percentages given, 9,000 tons each are used for bagging and upholstering, and 12,000 for paper stock, the total amounting, at a rough estimate, to over a million dollars.

The last census states that there were 60 mills in 1870 in the Western

States. For the whole country, in the same year, there were 90 dressed-flax mills, 33 for bagging, and 9 for linen goods. Those manufacturing dressed flax and linen goods were located in ten States. The following table gives the number of mills in each State, number of hands employed, and amount of production.

DRESSED FLAX.

States.	Number of mills.	Hands employed.	Value of material.	Value of products.
Illinois	5	78	$31,750	$91,400
Indiana	1	10	3,300	6,000
Michigan	1	3	2,660	5,700
New Jersey	3	5	24,000	33,300
New York	46	253	166,545	284,385
Ohio	27	358	136,509	346,405
Oregon	1	3	225	4,300
Pennsylvania	3	30	10,155	22,020
Vermont	1	3	1,540	2,500
Wisconsin	2	22	5,850	19,000

FLAX AND LINEN GOODS.

Michigan	1	5	865	1,225
Massachusetts	3	817	336,170	790,250
New Hampshire	1	88	132,000	175,000
New York	2	135	96,562	163,900
Pennsylvania	1	11	2,400	12,000
Rhode Island	1	250	128,000	374,400

By reference to the above table, we find that the total production of dressed flax for the whole country amounted to $815,010, while the manufactures are almost double, or $1,516,775.

In the manufacture of bagging, flax is not taken into account separately, jute and hemp being included. The materials used, however, in the 33 bagging-mills enumerated below were as follows: American hemp, 7,663 tons; flax tow, 3,050 tons; jute, 5,001 tons; jute yarn, 4,672 tons, and other materials to the value of $100,410, making a total valuation of $2,624,681. The products were: Bagging, 12,267,922 yards of bagging, 1,215,000 yards gunny-cloth, 942,644 yards cloth, 767,206 pounds yarn, and other products to the amount of $173,200, a sum total of $4,634,404. There were reported 406 looms working bagging, 5,103 spindles, 63 cards, and 289 hackles. The following is the table of bagging-mills in 1870:

BAGGING—FLAX, JUTE, AND HEMP.

States.	Number of mills.	Hands employed.	Value of material.	Value of products.
Illinois	2	113	[illegible]	$290,660
Kentucky	11	[illegible]	[illegible]	1,752,120
Massachusetts	2	234	106,000	210,000
Missouri	2	333	423,100	750,000
New Jersey	4	484	414,129	621,245
New York	4	209	131,900	215,500
Ohio	7	497	289,053	563,799
Pennsylvania	1	72	47,200	105,000
Total	33	3,170	2,624,682	4,607,064

What is the present status of the bagging industry? Hemp has entirely gone out of use as a bagging material, and jute butts, imported

at a very low rate of duty, have driven bagging flax to the wall. It is estimated that there were about 33,000,000 yards of bagging used to cover the cotton crop of 1879. Of this quantity about 28,000,000 yards were made of jute butts and rejections, and the remaining 5,000,000 of flax straw, principally in the Western States.

It is impossible to estimate the amount of American dressed flax consumed at the present time. The replies to the circular upon this question were not full enough to venture even a rough estimate. It is a ridiculously small amount at best, too small for a country boasting such diversity of soil and climate, and a farming element characterized by its intelligence and go-ahead energy. The quality of the last crop was considerably below the average, and the yield was likewise small. The quality of Irish flax has also been poorer, and it has advanced so rapidly in price that we have had to import more than ever of Russian, Belgian, and Dutch flax. It is stated that the Russian exportation of flax in various forms has averaged 80,000 tons for a series of years. Flax manufacture is increasing in this country, several new mills having recently been started in Massachusetts, and, with the revival of business, others will doubtless spring up and there will be a demand for all the flax that can be produced if it comes up to the required standard.

A prominent Boston manufacturer, since receiving the circular sent out by the department, has furnished the American Cultivator an interesting article showing the importance of this industry in American agriculture. The writer says in closing:

At one time, while Great Britain and Ireland had $40,000,000 and 1,000,000 spindles employed in flax-spinning, the United States had less than $1,000,000 invested in the industry. Almost every farmer can grow and manufacture a small crop of flax to advantage. The last census shows that 1,730,000 bushels of flax-seed were raised, an insignificant quantity compared with the importance of the article. This would be enough to support three linen factories of about 20,000 spindles each.

It is well known that American cordage is made mostly of Russian hemp,* and the government manufactures its own cordage for the rigging of its navy, also using Russian hemp. Looking to our own interests, wouldn't it be to our advantage to make our own cordage from American flax or hemp for about half the same money? Flax is more quiet in the market now, but it is believed that the demand for it is going to be much larger than it has been in past years. With the introduction of improved flax machinery, the yearly product should now be millions of bushels, producing fiber enough to make this country independent of the foreign product. The average product of seed is between 6 and 7 bushels per acre, with 600 to 900 pounds of straw. Compared with grain crops flax, in many localities, is a much better crop for farmers. The industry is destined to become an important branch of agricultural labor in this country, especially throughout the Northwest.

As an illustration of the extent to which hemp is used, according to the statistics of Massachusetts, in 1875 the stock used by linen and cordage manufacturers in that State was 1,912 tons of flax, costing $300 per ton, and 14,065 tons of American hemp, costing $100 per ton.

In a recent communication on the subject of Kentucky hemp, Mr. J. R. Proctor, of that State, says:

The manufacture of cordage from hemp began in Kentucky as early as 179[illegible], and of hemp bagging for cotton bales in 1801 or 180[illegible], and the increase in the manufacture of these articles was very great. In 1840 out of [illegible] establishments in the United States engaged in the manufacture of cordage, 111 were located in Kentucky. In 1850 the establishments in Kentucky had increased to 159, producing $2,311,[illegible] worth of bagging and cordage. In 1870 the manufacture had so declined that only 9 establishments were reported on cordage, producing $[illegible] worth of material, and [illegible] establishments engaged in the manufacture of bagging, using 6,[illegible] tons of American hemp.

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*The writer makes a slight error in this statement, as but little Russian hemp has been imported in late years, the American product being cheaper.

It is generally believed that jute bagging has permanently supplanted hemp bagging, and that hemp must seek other uses. While this is measurably true—and it is also that hemp is rapidly being introduced in other uses—it is also true that by improved processes in spinning tow it is possible to make a superior and higher priced bagging from hemp tow than from jute. The low price of Kentucky hemp, and the improved methods of softening and rendering it capable of being spun, will compel manufacturers to use it more than formerly, and we may expect to see an increased demand for hemp for spinning purposes.

The first Kentucky hemp hackled for the Eastern market was probably in 1844. The dressed line was sent east and was used in cordage; the tow was used in bagging at home, the dressed hemp costing the Eastern cordage-makers about $400 to $500 per ton. As the home demand has decreased the Eastern demand has increased. Ten years ago out of 5,000 tons of hemp "dressed" in Lexington the East took 2,200 tons; the remainder was made into bale-rope and bagging at home. Now the East takes all the hemp handled at Lexington and all the dressed hemp from Frankfort, showing an increased demand for hackled hemp in the Eastern market. Spinning machinery was first adapted to flax fiber. Gradually machinery has been made stronger and more suitable to the spinning of hemp, and in France, Italy, Bavaria, and other European countries the spinning of hemp by machinery has made rapid progress. The manufacturers in the eastern part of the United States began some years since to mix hemp with flax in the manufacture of yarns, crashes, twines, &c. The products, with the exception of coarse twines, being all sold as flax.

Hemp is not altogether a Kentucky product, although this State has for a long time led in its production. It can be grown with equal success in Missouri and Illinois and other Western and Southwestern States. Its cultivation, as far as conditions of soil and climate are concerned, could be extended over quite a range of country if the farmers were to turn their attention to it, and there was a demand for all that might be produced. The following letter from a Kentucky hemp manufacturer, bearing upon this subject, is worthy of perusal:

LEXINGTON, KY., *March* 12, 1880.

DEAR SIR: Permit me to make a few statements in regard to hemp culture. First, Kentucky has but thirteen counties that can grow hemp, and hemp land has been rented as high as $20 per acre, to be sown in hemp this year. To buy land it will cost from $80 to $100 per acre. That is too high for farming land and the hemp culture is finding its way west where land is much cheaper, and more hemp can be raised to the acre than here. It has been tried in Kansas and Nebraska in a small way, and has proved a success. Several farmers have gone from here.

I am fifty-four years of age, a rope and twine maker by trade, having gained my experience from working fibers for many years.

I remain, very respectfully,

CHARLES RICHARD DODGE, Esq. THEO. TEBAW.

On the Pacific slope jute seems to hold the first place in coarse fiber manufacture. Large quantities of Calcutta jute are employed in the manufacture of grain-bags, wool-bags, fleece-twine, burlaps for baling purposes, hop-cloth, yarns for fuse-making, and other uses. In 1879 one firm in San Francisco manufactured 6,000,000 bags, 12 ounces weight (22 by 36 inches), for the sacking of wheat; 100,000 bags, 3½ to 4 pounds (size 40 by 90), for baling wool; 100,000 pounds twine, and over 50,000 yards of burlaps. Bagging and burlaps are not the only uses to which the coarser kinds of jute are employed, as large quantities of this fiber are consumed by the Eastern manufacturer in making cordage and small rope for inland purposes, where no great strength is required. The finer jute fiber enters into the fabrication of many kinds of flax goods, such as coarse crashes, cheapening them materially, and answering the purpose just as well, provided they are always sold as mixed goods. Large quantities of jute and linen mixed goods are imported into this market from Scotland, which country it is said controls the jute trade. Until jute becomes a native product and is produced cheaply and in sufficient quantity to make it an American industry, for the sake of national prosperity, we can do no better than employ native fibers to as great an extent as possible in the manufacture of such goods as have

been enumerated above. That hemp is being so utilized by the Eastern manufacturers is a step in the right direction. What is needed is a steadily increasing supply and demand which shall build up a healthy industry.

The statement was made this spring, about planting time, that "our people [in Kentucky] are almost wild about hemp." Figures were given showing the prices paid for seed and rent of land, and it was surmised that the farmers might be "running it into the ground." This is one of the unpleasant phases of fiber production—and indeed the same may be said of any crop giving an irregular supply and demoralizing legitimate cultivation. The price is high; there is little of the product on the market, with a demand for it; and everybody goes into its cultivation pell-mell. In the mean time the manufacturers look abroad for their supply, buying largely and making contracts ahead; the new crop comes on, and prices are depressed; the farmer loses money, or at least does not meet with his expectations, and hemp culture is declared "a delusion and a snare."

While this should deter farmers from rushing into cultivation recklessly, growing the fiber because nearly everybody else is growing it, and expects to make a pile of money out of it, it should not prevent those who wish to make fiber production a part of their farm practice from going into its cultivation. Well-grown and carefully prepared fiber will find a market, and as manufacturers become certain of a regular supply there will be an increasing demand. Already there is a prospective demand for hemp in the manufacture of twine to supply grain-binding machines, which it is said may tax the productive capacity of two such States as Kentucky and Missouri. A correspondent of the Lexington Gazette, writing upon this new industry, says:

> Iron and wire have advanced so materially as to make twine much cheaper, besides being preferable in other respects. One pound of twine of the required tensile strength for binding grain, say 65 pounds strain, will measure 300 feet to the pound, while wire of the requisite tensile strength will only measure 100 feet to the pound, and thus it will be seen that twine at 30½ cents per pound (it is now 15 cents) is as cheap as wire at 10 cents per pound, and it is likely to be higher. One party in this city (Lexington) has a contract for sixty tons of twine to be used for binding grain, and some anxiety is felt to get an adequate supply. Twine binders are coming largely into use, and must eventually supersede the wire binders.

Although the use of hemp may be largely turned in the future to the manufacture of twine, cordage, and spun goods, it is still claimed by Western bagging-manufacturers that, if sown thick and cheaply converted into tow, remunerative prices can always be obtained for a fiber for bagging purposes. The class of hemp tow referred to, compared with jute butts, would command 2½ to 3 cents per pound. Our farmers can readily tell whether they can grow it at these figures and make any profit out of it. The statement was made by the Saint Louis Board of Trade a few years ago, that in the Eastern markets Missouri dressed hemp has the preference over that grown in Kentucky, at the same price, though the latter State with a large and superior crop in 1876 was able to undersell Missouri.

TARIFF CONSIDERATIONS.

How will tariff legislation better the prospects of flax culture? At present everything seems to favor the manufacturer. The argument is used that raising the duty would only increase the price of goods of domestic manufacture and make competition with foreign goods impossible, as we produce neither an adequate supply nor the requisite quality.

Such an argument has weight viewing the case from the manufacturer's standpoint, but would not a little protection at the same time prove an incentive to home production of the raw material and enable us to keep at home a large share of the $800,000 now paid out to foreign producers? As it is, little dressed flax is imported, the manufacturer buying scutched flax as a partially manufactured product, at a low rate of duty, and dressing it here. The ratio of foreign to native dressed flax used in the United States is said to be about 7 to 2. The flax is hackled in Europe, reducing it one-half while doubling its value, and it is then imported at about the same as the raw material. With a protective tariff a vast industry would spring up, and our farmers would reap a portion of its benefits.

There is another consideration of far more importance to the flax interests, the bare statement of which should prove its own argument. In the case of dressed flax it is claimed we could not at once furnish anything like a supply should the foreign markets be suddenly cut off. That does not alter the fact that we do now grow hundreds of thousands of acres of flax-straw, the greater part of which is wasted after the seed is taken off. Why is this vast production allowed to go to waste? A manufacturer of Muncie, Ind., thus answers the question:

It can only be attributed to defective and ignorant tariff legislation. In 1879 there was imported 11[illegible] pounds of jute butts, used exclusively for paper and bagging manufacture, at an average price of 1½ cents per pound, including $6 per ton specific duty. At this low price flax-straw manufacturers are unable to compete with jute butts. In the same year there was imported 1,300,458 bushels flax-seed, averaging $2.40 per bushel. Covering for cotton, allowed at 10 cents per yard, for which it could be furnished, would distribute throughout the Western States about $3,300,000 derived from an article that at present is principally wasted. Besides giving employment to thousands of laborers, it would also give flax culture an impetus that would enable us to supply the demand for seed instead of our having to grow corn, wheat, and hominy to export and trade for it, paying freight both ways, together with the different margins of speculators.

I would strongly recommend the appointment of a commission, comprising men thoroughly conversant with their respective branches of manufacture, *requiring* protection, in order that each may be intelligently represented in an action by Congress for the revision of the present tariff.

An Ohio manufacturer, writing from Cuyahoga Falls, says of the flax industry:

It was greatly hindered by the hostility of the New York cotton-brokers, apparently in the interest of the jute-bagging manufacturers, which led to the stoppage of our mills during the year 1879.

I do not know to what special action the writer refers, but I am informed by jute-manufacturers that the New York Cotton Board will receive no cotton whatever baled with flax bagging, giving as a reason that flax bagging is so dirty it makes a difference in the price of the cotton. This would seem an unjust discrimination—certainly in the interest of a particular manufacture—and tending to discourage flax-bagging manufacture. I cannot think, however, that the point is made against flax bagging in general, but against bagging made of unfit material.

In 1878 the various cotton exchanges of the country took action to discriminate against poor bagging manufactured from unfit material. Green or unrotted flax-straw is held to be objectionable when made into bagging, as cotton baled with such an article is not only injured by the fragments of bark and "shive," but is liable to be stained by it into the bargain. The Board of Trade of Saint Louis, in commenting upon the action of the cotton exchanges, says that native flax, if well prepared for use, reaches as high a standard as any other article used for the manufacture of bagging. In the Western markets jute has almost a monopoly, some hemp bagging still finding its way to market with occasional lots

of bagging from well-rotted flax. The prices of bagging in the Saint Louis market a year ago—the lowest ever known—ranged as follows: Flax, 7 to 8 cents per yard; hemp, 9 cents; and jute 9½ to 10 cents.

The following is received from Austin, Minn.:

Since 1872, when Congress took off the duty on jute, it has been impossible in this State to manufacture bagging for cotton baling. I had just undertaken to manufacture it. Now no use of the vast acreage of flax fiber is made but in one establishment in the State, and that for upholstering purposes. Thousands and thousands of dollars worth of fiber in this State and Wisconsin is rotting upon the fields. Although I am out of the business I am satisfied that, with proper encouragement, a new source of revenue might be opened to the farming and manufacturing interests of these two States.

At the recent Ohio agricultural convention, Mr. J. M. Allen, of Columbus, presented quite an array of interesting facts upon this subject. He has kindly sent me a synopsis of his paper, from which the following extract is taken:

In 1869 there were about 93 mills in operation—14 of them bagging-mills—running about 140 looms. Thirty-six of them were in Ohio, distributed through almost as many counties, giving employment to about 4,000 hands, who received some $500,000 per annum in wages. These mills consumed nearly 30,000 tons of raw material, for which the farmers received about $1,500,000. The operations of 1869 aggregated nearly $5,000,000, about all of which was direct production. The cotton crop of the country had to be bagged. In 1866 less than three-sixteenths of the cotton crop was covered with flax bagging, but such was the increase of production that in 1869 and 1870 quite three-fourths of it was thus covered, leaving but one-fourth to be covered by the foreign product. The flax crop had increased in the same period from 52,546 acres and 12,000,000 pounds to 90,005 acres and 60,000,000 pounds of fiber, an increase of about 400 per cent. With proper encouragement and protection this increase could have been maintained for years to come. But in 1870 the duty upon gunny cloth (the foreign product coming in direct competition with flax) was reduced to such an extent as to make the manufacture in this country impossible, and in 1871 every flax-mill in the country was closed, and privileges, machinery, and expensive experience went down.

The year 1871 in the above should read 1872, as in the year 1871 more flax was used in bagging than all other materials together. The production of Saint Louis alone for 1871 is stated in round numbers to have amounted to 3,250,000 yards. In this manufacture the raw material consumed was as follows: Flax tow, 14,199 bales; jute and jute butts, 8,561 bales; hemp and hemp tow, 4,756 bales. This shows a consumption of Western grown fiber (flax and hemp) to the amount of nearly 19,000 bales, 27,500 manufactured; a fraction over 30 per cent. only of imported jute fiber being used. The history of the year previous shows that the supply of the home product was not equal to the demand. The cotton crop of 1870, reaching nearly to 4,500,000 bales, taxed every bagging loom in the country to its utmost capacity; and even with the opening of new factories, large orders for bagging went abroad to make good the short supply which seemed inevitable. It is stated that there was constant antagonism during 1871 between holders of raw material and manufacturers, and, in order to effect sales, prices were gradually "forced down." This may have led to the reduction of the tariff on jute for bagging manufacture.

To return to the question of protection, even the manufacturers themselves desire a little "encouragement," in the way of a free introduction of the raw material as well as of machinery. The superintendent of one of the largest flax-mills in Eastern Massachusetts thus writes:

There is every encouragement in the world for investment in flax and hemp spinning. Properly conducted, it is a very remunerative business. One thing, our machinery should be introduced customs free—raw material also free. Our native skill, with a little added experience, will be able to keep from our market the millions of Irish, German, and French linens annually imported.

A Delaware jute manufacturer writes:

For several years past the absence of profit has been the chief discouragement. Now, however, with the revival of business, from its having been almost impossible to get the cost of production, a decided improvement in this respect has taken place. Should this state of things continue, as the quantities of jute goods imported largely exceed those produced at home, we have little doubt that the domestic production will rapidly increase. The machinery used is mostly imported at a duty of from 35 to 45 per cent. *ad valorem*. The raw fiber used is also subject to a tax of $15 per ton specific; while some of the principal productions, such as burlaps and carpet yarns, are subject to a duty of but 25 per cent. *ad valorem*. With the immense factories, large capital, and long experience of the British manufacturers, added to their ability to purchase the fiber at $15 per ton less than Americans, and their ability to buy machinery at about 40 per cent. less, including freight, it is almost impossible to compete with them where but a 25 per cent. *ad valorem* duty is imposed on their productions except when the price is high. Hence, the burlaps used in this country are almost exclusively imported.

Another manufacturer writes to the same effect, that the chief hinderance to successful flax and jute manufacture is foreign competition—not quite duty enough on coarse linen goods. If protection is good for the manufacturer, and will enable competition with the foreign markets, will not the farmer derive equal benefit from a protection which will enable him to compete with the foreign producers? It certainly is a poor rule that does not work well both ways. If the statement of our correspondent in Dayton, Ohio, is correct, that there is flax enough grown for the seed alone in the United States to supply all demands and uses for the fiber, and that a little protection against jute and foreign tows would place the flax industry of the Northwest upon its feet again, is it not worth consideration? The tariff question is a grave one to settle, as there are so many conflicting interests involved. It is a question that cannot be decided hastily in favor of the interest representing the greater amount of capital, or having the greater influence. "Powerful pressure" is a good motive as far as it relates to the running of a steam-engine, or the turning of a turbine water-wheel, and particularly so if the machinery of a large manufacturing establishment is moved in consequence; but it is not an agency to be used in securing wise legislation. There is but one way to grasp the question, and that in its relation to the best interests of the whole country. We cannot legislate for the benefit of the manufacturer alone at the expense of native production of the raw material; neither can we protect the farmer at the expense of the final consumer. There is a point, however, at which the best interests of all classes will be subserved, and any effort that may be made toward an equitable and just tariff in regard to fibers will lead to the establishment of native industries, which will prove to the country a vast source of wealth.

CULTIVATION.

In this limited report it is not proposed to give a treatise on flax or hemp culture, but to indicate briefly a few of the most essential points in its profitable production. That it is not an exhaustive crop, as urged by many, is abundantly proved by repeated chemical tests in this country and Europe, showing that flax takes less inorganic matter from the soil, per acre, than wheat, oats, barley, or tobacco. It must, however, prove an exhausting crop, as its cultivation is practiced in many portions of the West, where the seed is sold to the oil mills, the straw burned, and nothing returned to the soil. As the fiber is composed of elements taken almost wholly from the atmosphere, while the mineral elements of the soil are found in the waste material of the plant, the only rational course to pursue suggests itself.

If, therefore, only the fiber is sold, the oil extracted from the seed, and the residue made into oil-cake and fed upon the farm, the plant retted upon the land on which it

is grown, so that the glutinous substance washed out in the process be returned to the land, or, if water retted, the steep water pumped up and spread over the land, and the shive or woody part composted with the manure of the farm, or simply spread over the land, it will be found that, instead of deteriorating, land will steadily improve under the culture of these plants, and at the same time yield a fair profit to the farmer.

Foreign flax-producers are of the opinion that flax improves the soil instead of serving to impoverish it, and that a peculiar advantage attending the cultivation of hemp and flax is that a crop of the former prepares the land for the latter, and therefore a crop of hemp is a clear gain to the farmer. Hemp has been grown for a number of years upon the same ground in Kentucky without the fertility of the soil being perceptibly deteriorated. There seems to be no reason why flax culture cannot be carried on as profitably in this country as in any other if proper care is taken to keep up the fertility of the soil, due attention being paid to rotation, and, above all, bestowing upon the crop careful culture.

Mr. Proctor gives as the rate of yield of flax in Ireland 300 to 521 pounds of fiber to the acre, and an enormous yield of 1,210 pounds is recorded. The average yield for Belgium in ten years amounted to about 470 pounds. In France the figures are stated at 505 pounds, Holland 471, and Russia (where less care is taken) 280 pounds to the acre is recorded. Land is less expensive in this country than in foreign flax-growing sections, and importing the fiber must add to its cost, so there is every encouragement for flax-growing in this country for those who wish to farm with brains.

In selecting a soil for flax-growing, a moist, deep, strong loam upon upland will give the best results. Barley lands in the Middle States are held to be the best, and in the Western States new prairie and old turf lands are frequently chosen. A weedy soil is not to be thought of, and, in this connection, manures that are liable to contain ungerminated seeds should be avoided.

A New York State flax-grower of long experience considers that heavy clay loam stands first as regards both fiber and seed; gravelly loam second best—produced but half a crop; light sandy loam and coarse gravel third best. In Kentucky and other hemp-growing States this crop is considered "an excellent preparation for flax, freeing the land from weeds; and if the hemp was retted upon the land and the shives burned or, better, spread it in the spring, the land would be in good condition."

Flax culture in Russia is conducted upon alluvial soils, on the vast plains in the interior, which are subject to annual overflow from the rivers, leaving a rich deposit upon the soil. It is therefore the lack of high culture in Russia that accounts for the lower grades, and less quantity per acre, of flax. The roots penetrate deeply, and deep loam that is not liable to excess of moisture nor yet too great a degree of dryness, is the best suited to the crop. Such soils are found in river bottoms. The soil of much of our prairie land in the west will answer for flax culture, and recent timber lands are also considered good if there is proper drainage. It has been asserted that "the Livonians, when clearing a forest, burn the wood upon the surface as a preparation for flax," and that such a soil is preferred by them to any other.

One great element of success in foreign flax cultivation is the careful attention paid to the rotation of crops. In Flanders, growing the crop upon the same ground once in ten years is considered the best system, though the plan is not always adhered to. A favorite rotation in Flanders is potatoes; barley, seeded with grasses; meadow, cut for soiling

stock; pasture; and fifth, flax, or one-half in oats, so, on the return of the rotation, the part that was in oats may be put into flax.

Mr. Proctor states that it is the custom in Belgium on good soils to put in flax after clover, tobacco, hemp, or wheat, while on light soils the crop will be barley or rye, with turnips following them the same year. In Ireland one plowing after wheat is considered sufficient, though two and even three are better. Large crops are also obtained upon peat bogs and clay substratum. Of the soil of Belgium which grows the finest flax, it is said that its fertility has less to do with the successful production of flax-fiber than the careful culture bestowed upon it. In addition to this, it is to "the unstinted supply of manure, of which the quality and mode of action on the soil and plants is a matter of careful and anxious study, to an equally careful attention to the quality of the seed and the properties of the plant, and last, but not least, by carrying out a well considered system of rotation, that the Flemish farmer owes his success in flax-culture."

In our own country it is desirable to plow in the fall, and again in the spring as early as practicable. The soil should then be harrowed and reduced to fine tilth. If the land is at all cloddy it should be rolled. The best manures are phosphates, plaster, ashes, and salt. Three or four bushels of a mixture of equal quantities of the three latter have been used as a special flax-manure. According to Dr. Ure, 30 pounds potash, 28 of common salt, 34 of burnt gypsum, 54 of bone-dust, and 56 of sulphate of magnesia will replace the constituents of an average acre of flax. The Belgian farmer prefers liquid manure, "collected mainly from the cow-house, stable, &c., and allowed to ferment in cisterns built for the purpose; with this the oil-cake is mixed. The quantity of this manure varies from 100 to 300 hectoliters per hectare. As many as a thousand oil cakes are sometimes applied to an acre."

In Courtrai, where flax is rarely sown upon the same land oftener than every eighth year, generally following wheat or oats, the land set off for this crop the ensuing year is covered with farm-yard manure immediately after harvest; twenty-five to thirty cart loads are often applied to the acre. It is spread, plowed in four or five inches deep, and allowed to remain four or five months, when it is harrowed and plowed in again a little deeper, and at the same time trenched with spades. It remains in this condition during winter; it is harrowed in spring and liquid manure applied to the extent of 2,300 gallons per acre. In this country chemical fertilizers are preferable to other forms of manure, as they are free from seeds of noxious plants.

In the selection of seed the greatest care should be exercised to get that which is perfectly clean and free from the germs of weeds. As to the kinds of seed to plant, there are great differences of opinion. From experiments made by the Flax Society of Ireland, it was demonstrated that home-grown flax-seed yielded the best results. The Dutch Association for promoting the interests of flax industry recommend the White Blossom Dutch seed for American planting. It produces abundance of seed, but a coarse fiber. Where fine fiber is desired, the Blue Blossom Dutch is preferable.* In purchasing seed the heaviest, brightest, and plumpest should always be selected, and that which has not been taken from different crops preferred.

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* In the Kentucky flax and hemp report it is stated that persons desiring to import foreign seed for planting can order through their commission merchants, or they can get pure Russian seed from the following: Odessa Exchange Committee, Odessa; Bessarabian Horticultural School, Kishinef; Committee of Riga Exchange, Riga. The Dutch seed can be obtained from the Dutch Association above quoted, Rotterdam.

A bushel to a bushel and a half of seed is the average for New York and other States producing fiber, though for fine fiber it is recommended to sow two bushels. In Belgium and Russia, where the finest linens are produced, the average is two to four bushels. Of course, it is well understood that with thick sowing there is less branching, and the fewer and higher the branches are upon the stalk the better will be the fiber. When planted for seed, the reverse of this practice is observed, as the thinner the seed is sown the more branching will be the plants, and, in turn, more seed will be formed. Western farmers, growing for seed alone, sow only half a bushel, or three pecks at the limit; but Eastern farmers, desiring both fiber and seed, sow usually five pecks, and it is stated that the yield of seed is larger than that obtained by the Western farmer. Mr. Proctor advises sowing not less than two bushels of seed per acre, where a good fiber and profitable yield are desired. "Finer fiber is obtained from early-sown flax. Good results, however, can be obtained by sowing whenever conditions are right, from March to latter part of May." The sowing should be as even as possible, and the ground may be leveled with a roller, if it is designed to cut with a reaper. This plan of harvesting is hardly to be advocated, however, except where the plant is grown for seed alone. As the seed is very smooth and slippery, it requires considerable practice to distribute it evenly. In broadcast sowing, plants should stand about one inch apart over the field. Sowing by means of machinery has been suggested, though probably hand-sowing is the best method to pursue.

After the seed has been distributed as evenly as possible, a brush harrow, or harrow of short teeth, should be used, and even a roller is advocated in some cases to compress the earth and insure early vegetation. Objection is made by some to the introduction of horses upon the land after its final preparation and sowing. Mr. Todd, author of a prize essay on flax culture,* prefers a light brush harrow, made by boring holes into a piece of scantling, into which bushy twigs two feet long are fastened. If more brush is required, additional pieces may be nailed to the scantling. A man or boy can drag the machine over the field by means of a light pair of shafts. An inch is a sufficient depth to cover the seed.

After the plants are up they should be kept as free from weeds as possible, and the work should be performed while the plants are about five or six inches high. It is exceedingly doubtful, however, if hand weeding will be practiced to any great extent in this country as is done in Europe, and the greater care, therefore, is to be exerted in freeing the soil from weeds beforehand, and in the careful selection of clean seed. Women and children perform this work in Belgium, creeping over the field upon hands and knees, always working towards the wind, so that the young plants may be blown into an upright position again by the current of air coming from an opposite direction to that in which they have been pressed down.

The proper time to harvest is when the leaves begin to fall and the stalks to assume a yellowish tinge. The plan usually adopted abroad is to pull the flax, though much of it is harvested in this country with the reaper. The objections to the latter mode of harvesting are the loss of fiber and injury to its working qualities, and the gathering of weeds with the flax. A writer in a former report says that by cutting low, the ground having been previously rolled and kept free from weeds, the objections disappear. However, pulling undoubtedly gives the best results, where

*American Agriculturist.

fine fiber is desired. Allowing the seed to mature injures the quality of flax, and the seed will mature on the plant equally well after cutting or pulling, if it is suffered to remain until perfectly dry.

Wm. L. Lowrey, a practical flax-grower of New York, makes the following suggestions in regard to pulling:

This should be done when one-half or two-thirds of the bolls are brown. Allow me to remark that work on the flax crop has just commenced at this period of its growth, and that if the flax is uneven, poorly coated, and in wet spots badly lodged, it will be impossible by any other method to produce good fiber. On the other hand, if the flax is in quality and yield of fiber prime at this stage, and care be not exercised in handling and rotting, the result will be the same. Clasp several straws in the right hand, pass them to the left and pull with both hands. Repeat this until the hand is full, lay this down, repeat again, and then tie both handfuls in one bundle. At night we set up all that is pulled during the day in loose stooks. This method preserves uniformity in curing, and part of the flax is not sunburned while the other is green and unfit for sheltering. As soon as it is dry, draw it into the barn to whip.

Another method:

When the flax is standing erect, a handful should be grasped with both hands just below the seed-bolls, and pulled obliquely from the ground with a sudden jerk, the dirt adhering to the roots shaken off or knocked off against the boot. The handful or "beets" should be kept even at the root ends, of an even size, and laid straight upon the ground, two handfuls together crossing each other diagonally.

Second growth, or short flax, should be pulled afterwards, and bundled separately. The flax should be put in small bundles or sheaves, tied with sun-dried rushes or wisps of hay, or similar material, and not with flax straw, though if the seed is ripe the farmer may proceed with the rippling at once. As a general rule it is best to set up the flax in the field for a few days that it may be thoroughly dried. In Courtrai the flax is always dried in the field, stacked without rippling, and left for steeping until the next spring. To insure preservation of the seed, the straw is put into stooks without tying into sheaves, and placed upon cradles for preservation from dampness. "The seed ends are put in alternate layers, and the stooks are from four to six sheaves in height and from three to four wide, the whole thatched with straw." After thorough drying the flax is put into stacks like ordinary grain. Keeping for three years is said to improve the fiber, which will scutch more easily and profitably.

Separating the seed-bolls from the straw is termed "rippling," and it is performed either in the field or in the barn during winter. Much of the Irish flax is placed in the steeping-pools without the removal of the seed, though such a wasteful plan should not be practiced. Rippling is performed in many ways, among which may be named tramping the straw with horses moving in a circle; by the use of the cylinder of a thrashing machine; by drawing through a heckle; by rollers operating by horse-power; by thrashing with flails, or by whipping over a smooth stone or board. When done with a heckle—which is provided with iron or steel teeth set in a solid block of wood—the workman grasps a small handful of stalks near the butt end and draws them through the comb, a large winnowing-sheet having been placed underneath the apparatus to catch the seed as it falls. Leveling the ground and tramping it hard will answer the same purpose. One of the best methods of rippling is to pass the heads through plain rollers—allowing the heads only to come in contact with them—which crushes the bolls and allows the seeds to separate and fall. In Great Britain a machine is in use for this purpose constructed with a powerful framework, the rollers remaining free at one end, so that the flax-stalks may be held in the hand while the heads

alone are being subjected to the pressure of the rollers. The whipping process is thus described by Mr. Lowrey:

Place a flat stone on the barn-floor, with one edge inclined to an angle of forty-five degrees; set another under it to block it up; clasp the bundle with both hands near the roots, raise it, and with a smart stroke bring it down across the stone. Repeat it several times, until the seeds are mostly broken from the straw. Clean the seed with a fanning-mill.

The next process is the "retting," which is accomplished by two methods—water-retting and dew-retting. The latter is most practiced in this country, though the former gives the best results. The retting is simply a process of fermentation by which the gluten holding together the fibers in the stalk is dissolved and the woody core or "boon" is decomposed, so that the flax when broken will be easily detached from the waste matter called "shives." In dew-retting a ton of straw is spread evenly over an acre of moist meadow, about the 1st of October, the bundles a foot apart and in straight rows. They are turned occasionally by inserting a pole under the straw and opened with a fork, if the retting is found to be progressing unevenly. The time varies for the operation, the condition of the straw and state of the weather having much to do with it. One to two weeks in good weather is considered sufficient, though in dry weather a much longer time is required. Water-retting requires from five to ten, and in some cases even twenty to thirty, days. It should be carefully watched, and taken out of the water as soon as the fiber begins to separate from the core or woody part and the harl or cuticle will peel from the fiber.

The softest water is unquestionably the best for steeping, and river water is therefore preferable to spring water. It is thought that flax is given a better color when retted in a slow-running stream than in stagnant water, as all impurities are removed. Where access cannot be had to rivers or to lakes or ponds, the farmer must construct steeping pools. These pools are generally 12 to 18 feet long, 6 feet wide, and 4 feet deep. It should be protected from the wash of surface water. When a small running stream can be carried through the pool it will be found quite advantageous; more so than when spring water is used. If spring water only be available, it is best to fill the pool some six weeks before it is needed for use, in order that the influence of the sun and air may soften the water. It should also be kept clean and free from mineral and vegetable impurities. A pool 38 feet long, 3½ to 4 feet deep, and 10 feet wide will serve to ret an acre of flax. A writer in the journal of the (British) agricultural society states that water which has flowed over peat or has lain on peaty soil for some time is very good for retting flax, the antiseptic properties of the peat correcting the usual defects of stagnant water. In regard to the influence of the bottom of the pit upon the color of the fiber, clay bottom is said to give a yellowish-white tinge, alluvial soil a bluish shade, while peat often gives a very pure white.

In placing the flax in the pool the sheaves are packed loosely, a little sloping, and resting on their butt ends. One layer in a pool is best, though two are sometimes packed. Sometimes the work is done before the water is let in, where there is a ready supply, enabling the workmen to place the flax more regularly. The Irish flax-growers say that flax must be covered from the light by sods, with the grassy side underneath, or with long wheaten straw, kept down with stones or heavy logs of wood. The point is to keep the flax entirely under water, without coming in contact with the bottom of the pond or pool.

When fermentation begins to take place the water shows signs of tur-

bidity and is slightly discolored; gas begins to be evolved and is given off with unpleasant odor. As the decomposition becomes general more weights will be required, for the flax swells and rises. A thick scum is formed upon the surface of the pool, which, if possible, should be removed by allowing a slight stream of water to flow over the pool. It is not possible to give any limit of time for the perfect accomplishment of the retting. In warm weather, with occasional rains, the time will be hastened; cold nights, on the contrary, retard the operation. Coarse flax requires a much longer time than fine. The writer quoted above says:

> When it is ready to take out it will be observed to sink in the pool; but it requires a much more careful examination from time to time. The test in Holland is as follows: A few stalks of average fineness are selected and are broken in two places a few inches apart. If the inner part or wood will then pull easily out with the fingers, and does not break the fiber or drag any of it with it, the flax is considered sufficiently watered. If allowed to remain longer the fiber is injured, and becomes weak and cottony. If taken out sooner than this test shows to be advisable, much of the fiber is knocked away in the scutching, and the general quality is dry and coarse. The test should be tried at intervals of three or four hours after the fermentation ceases, for if the weather be warm the change for the worse is rapid.

As soon as the retting is completed the flax should be lifted from the pools, and upon this operation too much care cannot be bestowed, as the use of implements, as hooks or pitchfork, only serve to injure the fiber. The weights are removed, and the straw or sods taken to the manure-pit, as in their water-soaked condition they contain valuable elements needed again in the soil. The bundles should be taken out of the water by hand, two or more persons assisting in the operation. They should then be set up upon their butt ends in the field to allow the water to drain off gradually. It is ready to spread in twenty-four hours after taking out, though rain will retard it to thirty-six hours.

The next process is the spreading or grassing, by which the fiber is cleansed and improved in color. A newly-mown grass-field will answer for this purpose, and the flax is evenly and thinly spread over the field. The flax should be turned once or twice, by means of poles 8 or 9 feet long, to insure uniformity of color, and the grassing is finished in three or four days. Thoroughly dried fiber separates from the woody matter, contracting slightly, and when this is noted it is time to lift; or a few handsful may be tested with the scutching-machine. When lifted tie in sheaves, pack under cover, and the flax is ready for scutching, or can be kept for years, if so desired. This account, condensed from a prize essay by James MacAdam, jr., a former secretary to the Royal Society for Promotion and Improvement of the Growth of Flax in Ireland, will give American cultivators a knowledge of the best practice with flax-retting in Ireland, where the greatest care is bestowed upon the operation.

All writers seem to agree that the waters of the river Lys, in Flanders, are particularly favorable to flax-retting. Steeping is there carried on as a trade by men who have no other occupation. The Courtrai flax is all steeped in the river, large quantities of flax being brought great distances for the purpose. Mr. Proctor's account of the Courtrai treatment of retting is so concise I give the quotation entire:

> The flax tied up in small bundles is placed perpendicularly in wooden frames or crates of from twelve to fifteen feet square. Each crate is launched into the river, and straw and clean stones laid upon it until it sinks just enough below the surface of the stream to leave a current both above and below it, which carries away all impurities and keeps the fiber clean during the period of immersion. The average time required is from seven to ten days. Towards the end of May the average is nine to ten days; in August, seven days; in October, twelve days. As soon as the flax has been sufficiently steeped, the crates are hauled ashore, and the flax spread upon the grass to

dry, preparatory to undergoing the process of breaking and scutching. The "*rouissage*" at Courtrai is usually performed in May or in August and September, after which the flax merchants of Brabant and the north send their agents among the farmers, who purchase from house to house, and on a certain day attend the chief town to receive the "deliveries," when the qualities of the crop and the average prices are ascertained and promulgated for the guidance of the trade.

The author just quoted advises beginning with dew-retting, to be followed with water-retting after the farmer has gained experience. There are several patented processes of rotting, by which the disintegration and decomposition are hastened by raising the temperature of the water artificially, or by treating with steam. In this limited report, however, it will be as well to omit further mention of them.

HEMP.

This being a much coarser fiber than flax, requires a good, strong soil for its production. Any good, rich, loamy land is adapted to this crop, as the blue-grass region of Kentucky, the limestone prairies of Missouri, or the fertile plains of Illinois. What has been said concerning the preparation of the soil for flax will apply equally well for this crop. Fall plowing upon heavy soils will greatly improve their condition, as the influence of the frost is beneficial. The land should be again stirred in the spring, though the last plowing should be quite shallow, that the surface soil acted upon by the frost may be retained. It may be left to the sun's influence for a few days, when it is ready for the seed. One bushel of seed is generally sown to the acre in Kentucky. It is thought that "there is nothing gained by sowing more than enough seed, as the hemp if too thick will thin itself by smothering out the smaller plants, and this must be done at a loss to vitality." The best seed is of a bright gray color, and should be well filled.

There will be little trouble with weeds if the first crop is well destroyed by the spring plowing, for hemp generally occupies all the ground, giving weeds but little chance to intrude. For this reason hemp is regarded by some agriculturists as an excellent clearing crop when introduced into rotation to precede flax. Hemp is diœcious, bearing male and female flowers, both of which can be used for fiber, though the male hemp ripens earlier than the female. In Europe it is stated that hemp is often grown in plats or beds with paths between, that the male and female stalks can be pulled separately. The female plants do not mature their seed until about three weeks after blossoming; they should be allowed to stand until the lower seeds begin to ripen, when it is time for harvesting.

Hemp was formerly pulled by hand, and is now to a certain extent in European countries. It is now harvested by cutting the plants off at or near the ground by means of a heavy knife or implement made specially for the purpose. This implement is crooked upon the edge, and is bent toward the shaft of the handle, so that by a rapid stroke the stalks are severed. Machinery is sometimes used when the stalks are small.

In cutting, the stalks must be laid in rows, even at the butts, and should be allowed to lie for a few days, a week at the farthest, to dry. When the crop has become sufficiently dried the stalks may be put up in bundles—the remainder of the leaves will for the most part drop off—and the bundles should be set up in shocks to dry thoroughly before stacking. "If the hemp is to be water-retted the drying is unnecessary, and some authorities think that better results are obtained when the hemp is retted immediately after harvesting. It is said that hemp steeped green will require only four days, but if allowed to dry eight

days will be required to steep it in water." Late-cut hemp is frequently put into shocks after spreading without being bound up, a simple band keeping the shock standing. Binding into sheaves, however, after curing, and placing in round stacks or ricks until spreading-time, is the best practice. Manufacturers prefer a water-retted hemp, and the Navy regulations are said to call for it: the price, however, for cordage hemp has hardly warranted the expenditure of the extra labor required, and our farmers, as a general rule, dew-ret their hemp. With the demand for spinning-hemps at better prices there will be a call for water-retted fiber. Farmers are not only unwilling to take the trouble, but few have the necessary skill or appliances. Retting by water has been carried on in a small way in Illinois; and it is said that Henry Clay introduced the practice into Kentucky, but it was not followed for reasons given above.

Mr. Proctor says that the best time for spreading hemp for dew-retting is in November or December, but it is well to begin spreading sooner if there is a large crop, that the labor of breaking may be commenced earlier. Hemp retted in winter is of a brighter color than that spread in October. It is usually stacked and spread upon the same ground upon which it is grown, and when sufficiently retted, as can be determined by breaking out a little, it is again put into shocks. If the hemp be dry the shocks should be tied around the top tightly with a band of hemp to keep out the rain. The shocks are made firm by tying with a band the first armful or two, raising it up and beating it well against the ground. The remainder of the hemp is set up around this central support. By flaring at the bottom and tying well a firm shock can be made that will stand firmly without danger of being blown over by the wind.

The slat hand-brake is used in Kentucky, the machines being carried around the field to avoid the removal of the hemp straw.

RAMIE.

The question of ramie cultivation, which attracted so much attention in the South some years ago, is not by any means a dead issue, or an abandoned experiment. The results obtained at that time proved that the plant was successfully introduced into the country, though its successful production—so far as making its cultivation an industry was concerned—fell short of the mark. The cultivation of ramie has been carried on in late years—in a small way, it is true—in New Jersey, under the direction of Emil Lefranc, the veteran ramie culturist of Louisiana, with a fair measure of success.

Mr. Lefranc writes me that winter is not so great an obstacle as it is thought to be. Covering the plants saved them well enough last year, and as it gives three crops a year in its Northern home there is almost the same chance of profit here as in the South with more cuttings. Five crops have been cut in Louisiana the same year.

A number of gentlemen in the vicinity of Newark and Philadelphia have grown ramie during the previous year, and I am informed that parties in Maryland propose to go into its cultivation quite extensively.

Mr. Dennis, of Newark, has purchased land in Virginia, which he expects to devote to ramie cultivation, and now that the New Jersey legislature has passed a bounty bill encouraging its production in the State we may look for others embarking in it for profit. Another encouragement is the recent invention of a ramie machine, described upon another page, which does its work most effectively, and removes one of the greatest obstacles to successful ramie production.

The ramie plant, *Boehmeria tenacissima*, was first introduced into this country in 1855, from the botanical gardens of Jamaica, and cultivated

in the United States Botanical Garden, and subsequently in the experimental garden of the Department of Agriculture. (See annual report of this department for the year 1867, page 220.)

In the report of the department for 1873, Mr. Lefranc states that it was introduced from Mexico in 1867. The writer says "to two persons is due the credit of its introduction into the United States, viz., Monsieur Ernest Godeau, in that year consul of France in New Orleans, and Benito Roezl, a Bohemian botanist, once a resident of Santa Compana in Mexico."

In this year it was given a fair test and abundantly proved its adaptability to the new soil and conditions, as many specimens now in the museum of the department will testify. Through the intelligent efforts of Mr. Lefranc and others interested in promoting this industry, practical direction was given to the experiment, and the question of manufacture, or rather of preparation, as well as production, fully considered.

In the annual report for 1873 (quoted above), published just six years after the reintroduction of the plant, there is a full and comprehensive article giving the results of the experiment, after the first fever of enthusiasm had subsided. In this it is shown that the plant had held its own during that time, even propagating in rich alluvial soils without cultivation. It was also grown from the seed, notwithstanding the impression that it could only be grown from cuttings. See article in Report Agriculture 1870, page 170, from which the following extract is taken:

> The ramie plant, or China grass of commerce, cultivated in many parts of the South from seeds furnished originally from this department, is found well adapted to that portion of the country, and when it can be utilized cheaply it will become a staple crop. * * * In Goliad, Tex., it grows well both from seed and roots; and in Austin the staple is reported long, fiber excellent, white and silky.

Reference is also made to other localities where grown.

Of perennial growth, the stems die in winter, but new growths shoot up in the spring, producing strong vigorous stalks in so short a time that it is an easy matter to secure four crops a year, and the plants are better for the cutting. A specimen in the museum, some 4 feet long, or more, with the fiber disintegrated for half its length, was from the fifth cutting in the same season in Louisiana. Thus it is proved that successful cultivation is possible, though "destructive overflows, and finally the discovery of the fact that water was too near the surface of the soil for such deep-rooting plants, caused the suspension of the enterprise in that section, which, moreover, has become, from social and political turbulence, very unpropitious for any new industry." Believed to be a semi-tropical plant, it was not until the Department of Agriculture grew it in the open air in the centennial grounds that the idea of adaptation to a northern climate was suggested. Here was the commencement of the more northerly experiment with the plant, though it was already known that in the colder regions of Northern China the roots are dug up and kept through the winter in cellars for replanting in the spring, like potatoes.

Judge Watts, then Commissioner of Agriculture, resolved to proceed with the experiment; Mr. Lefranc was commissioned to conduct it, and the first Jersey plantation, at Camden, was started with roots from the "Centennial patch," and those saved from inundation in Louisiana. Regarding the success of the experiment, I give Mr. Lefranc's own words:*

> I was surprised that the growth turned out superior to any growth in the South, and standing all winter without the least damage, sprouted abundantly in the follow-

* First New Jersey report of labor and industries.

ing spring as if it were in its congenial sphere. This prolific and vigorous growth increased in luxuriance and number of stems all the summer, especially after each cutting. * * A large quantum of minerals, phosphate, and silicious elements in the soil, and oxygen and carbonic acid in the air, account for the superiority of New Jersey over other sections regarding that plant, which, unlike cotton, has all its value in the bark, like flax and hemp. Ramie derives its principal food from the air. That explains the possibility of its triple annual cuttings and extraordinary abundance without exhausting the soil more than any other plant. Three crops of four and five feet each are certain from April to October, after the first season has formed the stand. Being protected against deep frost by a thick coating of leaves, hay, or straw mixed with some stable manure, the stand will last indefinitely and constitute a permanent income. The leaves of the plant itself will do very well for that covering and manuring; when dried, leaves are non-conductors of cold, and they generate—especially ramie leaves—a certain amount of ammonia, which is a good fertilizer. The experiments referred to were made in ordinary sandy soil, such as is found all over West Jersey.

The experiments were repeated at Haddonfield and Newark by a number of gentlemen interested in ramie culture. As to yield, where the stand is fully established, it is stated that three crops of stalks, 4½ feet in length, will give 8 tons of dried stems and 1 ton of cleaned fiber per acre, or about 12½ per cent. Ten dollars a ton is the most recent figure given as the possible value of the dried stalks bundled.

As the report of this department for 1873 may not be available to many readers of these pages, I will give a brief extract from the ramie article to which reference has been made, describing the mode of culture, and the manner in which stands are obtained. At the time it was written ramie culture was confined to Louisiana. It is as follows:

First. Whether for nursery purposes or for cultivation, the land must be sufficiently elevated to receive the benefit of natural drainage, because the roots will not live long in a watery bottom.

Secondly. The soil must be deep, rich, light, and moist as the sandy alluvia of Louisiana. Manure supplies the defects in some lands in these respects.

Thirdly. The fields must be thoroughly cleaned of weeds, plowed twice to the depth of eight to ten inches if possible, harrowed as much as a thorough pulverizing requires, and carefully drained by discriminate lines of ditches. Water must not be allowed to stand in the rows of the plant.

The land being thus prepared, planting becomes easy and promising. December, January, and February are the best months in which to plant. Roots, ratoons, and rooted layers are the only available seed. They are generally four or five inches long, carefully cut, not torn, from the mother plant. The dusty seed produced by the ramie stalks in the fall can be sown, but it is so delicate and requires so much care during the period of germination and growth that it seldom succeeds in open land.

Furrows 5 or 6 inches deep and 5 feet apart are opened with the plow. The roots are laid lengthwise in the middle, close in succession if a thick stand of crop is desired, but placed at intervals if nursery propagation is the object in view.

The first mode will absorb 3,000 roots per acre, but will save the labor of often filling the stand by propagation. The second mode will spare three-fourths of that amount of roots, but will impose the obligation of multiplying by layers. Being placed in the furrow closely or at intervals, the roots are carefully covered with the hoe. Pulverized earth and manure spread over the roots insure an early and luxuriant growth in the spring. When the shoots have attained a foot in height they are hilled up like potatoes, corn, and all other plants that require good footing and protection from the fermenting effect of stagnant water. The intervals between the rows being deepened by the hilling have also a draining influence, which can be rendered still more effective by ditches dug across from distance to distance, say 15 feet.

Good crops are obtained by thickening the stands. The stems are then abundant, fine, straight, and rich in fiber. Close planting is then necessary, inasmuch as it prevents the objectionable branching of the stalks. The period at which the plant is ripe for cutting is indicated by a brownish tinge at the foot of the stems. At that early stage the plant, though greenish, yields a fine and abundant filament. The first cutting may be unprofitable on account of the irregularity and sparseness of the growth; but if the stand is razeed and manured over the stubbles the ensuing cuttings will be productive. For that purpose the field must be kept clear of grass until the growth be sufficiently dense to expel the parasites by its shade. That necessary density is obtained by means of the important laying process. This consists in bending down, right and left along the growing stand, the highest switches, and in cov-

ering them with earth up to the under tip, which must not be smothered. One of the causes of the perennity and of the vigor of the plant is the nourishment it draws from the agencies of the atmosphere. Consequently the leaves of the layers should never be buried under ground. When properly performed, laying is very profitable; it creates an abundance of new roots, and fills up rapidly the voids of the stand.

After two years the plants may be so thick as to spread out in the rows. Then the plow or the stubble-cutter has to chop in a line, on one side, the projecting ratoons. If well executed, this operation leads to notable advantages. It extracts roots or fractional plants suitable for the extension of the cultivation elsewhere; it maintains, as a pruning, a vigorous life, and develops a luxuriant growth in the stand. If always applied on the same side of the row, this sort of stubble cutting has the remarkable advantage of removing gradually the growth toward the unoccupied land in the intervals, and of pushing it into a new position without disturbance.

That slow rotation preserves the soil from rapid exhaustion, and the ramie from decay, through the accumulation of roots under ground. Of course this lateral plowing will not prevent the opposite row from receiving the benefit of hoeing after each crop. Experiments made in Louisiana have demonstrated the efficiency of that method, to which are due the preservation and propagation of the plant in that State, while it has been destroyed in other sections for want of similar care.

This will serve as an outline of instructions for those who contemplate making an attempt at cultivation, though, of course, the practice of two sections of country as remote from each other as Louisiana and New Jersey, or even Maryland, must differ to a certain degree. If further instruction is needed—although I have no authority for making the statement—I am quite sure that Mr. Lefranc will be pleased to give special information to any who may apply to him that desire to go into ramie culture, whether for experiment or profit.

In addition to Mr. Lefranc's statements, the following letters, which have been received since they were made, offer additional evidence that several crops of stalks cannot only be produced, but that seed may be matured. They are as follows:

PHILADELPHIA, *March* 18, 1880.

DEAR SIR: Yours of the 11th instant was duly at hand. I planted some ramie-roots on my place at Haddonfield, N. J. The roots started in a short time, and I think each propagated 100 from 1. They gave several cuts of stalks in one season, which Mr. Lefranc took and treated in his own way. My opinion is that, so far as cultivation is concerned, there is no doubt about its success.

Yours, truly,

CHARLES R. DODGE, Esq. WM. MANN.

NEW JERSEY STATE AGRICULTURAL SOCIETY,
Secretary's Office, Newark, March 13, 1880.

DEAR SIR: In reply to yours of the 11th instant, I would state that my experience in the growth of ramie is limited to trials from the seed only, and that of one season. I sprouted my seed in the conservatory. In May I planted in the open ground in both strong and weak soils; all the plants gave me matured seed the last of September, the stronger soils favoring the growth and earlier maturity. I doubt the success in this latitude in obtaining seed from plants, but should cuttings favor more than growth from seed, the seasons might give a satisfactory yield.

Yours, very respectfully,

CHARLES R. DODGE, Esq. WM. M. FORCE.

The few replies to the circular received upon the subject indicate that the value and use of the fiber is little understood by manufacturers. The following brief extracts will serve as illutrastions:

[161] Having seen samples of it do not consider it suitable for general cordage, owing to shortness of the fiber. The ordinary rope machinery would not answer for its manufacture, but it would have to be handled the same as cotton.

[52] I have had some of the vegetable fibers, China grass, &c., but the expense in reducing them to that degree of softness essential to perfect spinning practically excludes them from all competition with flax and hemp.

[20] Flax fiber is the strongest and most valuable.

[72] We have had samples of ramie in its raw state, but not made into yarn. Our opinion was that it would make very nice lines if properly spun.

The inventor of the yucca machine thus writes:

> I cultivated it [ramie] about three years and found no difficulty in its cultivation, and in separating the woody matter and pulp from the bark, with the yucca machine, but could not extract the glutinous matter from the bark without the use of chemicals, which made the fiber unprofitable.

As the cultivation and preparation of the fiber are two distinct things, it is suggested that the industry be divided into producing and manufacturing. Capital should furnish the cleaning mills at convenient points, establishing a fair rate of remuneration for the raw product in bulk, as is practiced in Louisiana by the sugar-cane factories, and the farmer should be encouraged to grow the plants.

This leads to a further consideration of the subject, the question of machinery for extracting and cleaning the fiber to fit it for the manufacturer. As has been shown, ramie can be produced in any quantity, the only drawback to its becoming an important industry having been the lack of an economical means of separating the fiber after it has been grown. This same drawback exists in India, where the government has encouraged the cultivation of the plant, and in 1869 offered prizes amounting to $35,000 for cleaning-machinery that should come up to certain requirements. There is no record that such machinery has not been invented, although much has been done in this direction that may ultimately lead to success even in our own country.

The description of a machine invented by Mr. Lefranc will be found in the annual report of this department for 1873. That this piece of mechanism did not fulfill the requirements of a perfect ramie machine is evident from the fact that the invention has practically been abandoned, and the inventor's efforts turned in another direction, and I am given to understand with good success, as may be gleaned from the following extract from a letter recently received from Mr. Lefranc:

> I have a mechanical and chemical apparatus transforming it [ramie] satisfactorily into a commercial product, and am ready to buy the plant at $10 per ton in the stalk to start a central factory. It is in view of opening a sure market for the product that I am so anxious to have it spun here. Exports would not pay sufficiently, and out of this country there is no inducing outlet. Covering the plant saved it well enough last year, and as it gives three crops of over four feet there is almost as much chance of profit here as in the South with four crops. The machine and process I use for extracting the fiber were intended for the India competition prize, but we found that such an undertaking would cost too much. Besides this objectionable point, the abandonment of the invention to the Indian countries makes it almost a public property. This is the reason why the process is not made public.

As we have made reference to a new ramie machine, it may be well to state here that it is the invention of Mr. A. Angell, of Newark, N. J., and that it is considered successful. The machine is fully described in another portion of this report, under the heading of "Fiber machinery." A number of other ramie machines are mentioned in the list of patents given in the appendix, though nothing can be said of their merits or demerits, as I have failed to learn anything concerning them, though making the effort so to do.

Ramie manufacture in this country is one of the problems that only time and persistent effort of the friends of ramie culture can assist in solving. There are most beautiful examples of poplins, mozambiques, and other dress goods in the museum of this department, manufactured in Bradford, England, that for several years attracted attention and were popular; but fashion dictated a change, and it is now stated that the use of the fiber is restricted to upholstery goods, though there is a doubt if it is not usurping the place of a more expensive fiber, for which it is a profitable substitute. It bears a close resemblance to silk, and,

worked into silken fabrics, there are few of the uninitiated who would be able to detect the fraud. We used to hear it remarked that "it is the ramie fiber that makes silk dress-goods crack."

When mixed with worsted—under its own name—it shows to best advantage; indeed, it is claimed that the worsted machinery is the only system upon which it can be successfully worked. According to the "Textile Manufacturer," experiments in combing recently made in Philadelphia proved that the ordinary worsted process can treat it as fine, if not finer than mohair, with the advantage of being a pure lustrous white. American prepared ramie, in comparison with the British—according to the same journal—is more easily worked, the last-named being stiffer, more hairy, and less "docile" to the twist than the home product. A brittleness which acts against it in Europe is believed to come from the excessive hackling of the English method of treatment. It is for progressive America to take this manufacture in hand, and, with "Yankee" inventive genius, make a profitable industry out of it, alike for producer and manipulator, through the many applications yet unknown. In Europe, old routine is the great obstacle in the way of large and complete development of any new thing. "Industries are cut up by specialties, for one concern imports ramie from India and China; another prepares it into fiber for comber; this manipulates it for the spinner, and this for the weaver. Each one makes it a secret affair and a rare profession, working with closed doors against any visitors." The American concentrated method of treating such things is far more propitious for rapid progress and the acquirement of new ideas.

The exact status of this industry in the United States may be most easily presented to the reader in a communication from Mr. Lefranc, in answer to questions submitted to him upon this subject. He says:

Ramie, as well as abutilon, althea, and other American fibers, could now be turned into commercial products should the supply be made certain. But the spirit of enterprise has not yet taken that direction. Liberal offers to buy the plants have not succeeded in creating the required interest. No farmers have taken the trouble to gather the wild material nor to plant any. It will take time and exertion before a regular production can be established, unless some powerful organization takes the lead in starting cultivation and factories.

A certain amount of New Jersey and imported ramie is now on the market and offered to manufacturers in proper condition for spinning. It being a new fiber for them, and anticipating some loss of time in studying its manipulation to make yarns, they are generally very reluctant to undertake it, and decline to do it in this busy season.

The worsted machinery being limited here, and it being the only system suitable for ramie spinning, the obstacle is more serious than it appears at present. The only attempt so far made with the carding system, which is most suitable for the noils, or refuse of the combed long staple, was that of a mixture of short ramie with wool for knitting-yarn. But from this experiment to the point of a regular adoption there is a space to be crossed over, the test of the knitting or weaving and the test of time and wear on the goods.

Such are the difficulties now hindering the final stage of ramie as a commercial product. As to production of the fiber there is no more difficulty; it can be produced mechanically and chemically in a satisfactory manner. The whole point in question now is that of inducing worsted spinners to undertake the spinning.

JUTE.

It is now about ten years since the Department of Agriculture became interested in the subject of growing India jute upon American soil. Seed was distributed in 1870, and experiments conducted in South Carolina, Florida, Georgia, Louisiana, and Texas. The result has shown that the plant can be profitably grown "wherever in the Southern States there is a hot, damp climate and a moist soil of sandy clay or alluvial

mold." The yield was in some cases at the rate of 2,500 pounds to the acre, some of the stalks reaching a height of 15 feet. Throughout the monthly report of the department for 1871 there are statements, from actual experience, of planters which are worthy of perusal. Professor Waterhouse states that in some instances the fiber was, in the judgment of experts, superior in strength to that of the India fiber. He further stated that jute butts can be produced in the United States for 3 cents per pound, and the fiber for 8 cents, basing his estimates upon practical experience. Imported jute costs (for butts) 3 to 5 cents per pound, and the fiber 8 to 12½ cents.

The most recent facts in regard to the cultivation of India jute in this country are given in an article by Professor Waterhouse in the appendix.

OTHER FIBROUS PLANTS.

The replies to the circular contained little information regarding new or partially tried fibers. As a general rule manufacturers are the last persons to interest themselves in new fibers, especially when the questions of their cheap production and the possibility of a supply are yet to be settled. Even a plant of which so much has been written as ramie, appears to be little known or its uses understood. I do not mean to imply that manufacturers are opposed to the introduction of new fibers into commerce, as there are scores of manufacturers who would gladly test any new product, if received in sufficient quantity to make it an object. By special inquiry, however, considerable information was gleaned from various sources regarding those fibers whose experimental culture and treatment have been attracting attention in late years.

Among the indigenous fibers having the greatest claims to recognition, are the Indian mallow (*Abutilon avicennæ*) and the swamp rose-mallow (*Hibiscus moscheutos*). The first-named is a troublesome weed, growing throughout the central portions of the United States, often attaining a height of six or eight feet. It produces a good fiber, which is capable of being utilized for many purposes. It is an annual plant, seeding itself from year to year, and is particularly thrifty when grown in corn land. The rose-mallow grows in swamps, and can be cultivated upon uplands; it has the advantage over the preceding of being perennial. The fiber is very similar to that of the *Abutilon*, and both plants can be successfully manipulated upon the Angell machine mentioned above. Mr. Charles Taylor, of Englewood, N. J., says of the mallow fiber:

> Hemp is an important industry in Kentucky, but the people of that State will be surprised to find that mallow will be a more profitable crop. The yield of fiber from mallow will probably be four or five times as much as the yield of hemp per stalk or acre. The day the mallow is cut it goes through the mill, the sooner after cutting the better, and the ribbons can be immediately boiled and dried, and they are ready to pack for market.

Specimens of the fiber of both species were submitted to Messrs. Tucker, Carter & Co., New York, by Mr. Samuel C. Brown, in my presence, and pronounced upon favorably. The offer was also made to test the fiber by manufacture into cordage, &c., provided a ton or more could be furnished. If it could be put through the same machinery as Russia, Manila, and Sisal hemp, and placed upon the market its exact value as a commercial product would very soon be decided. These fibers are more fully described in Part I.

Among the foliaceous fibers whose growth and preparation might form new fiber industries, may be mentioned the Yucca and Sisal hemp. The latter, doubtless, could only be cultivated in portions of Florida,

and whether it would be able to compete with the same fiber produced in Yucatan at the present time is a question that would have to be settled by actual experiment. It probably would be able to hold its own, however. That there would be a market for all the fiber that might be produced there is not the least question. There are manufacturers now in New York that would be glad to get it, provided it was up to the standard in quality. Sisal hemp has risen rapidly in favor as a cordage material, and especially since the introduction into Yucatan of improved processes and machinery. It has driven New Zealand flax entirely out of the market, and holds its price now at only a cent less per pound than manila, for the manufactured article. Dr. Perrine, fifty years ago, demonstrated that the plant would flourish in Florida, and we point to the industry as one worthy of development. The price of Sisal hemp in the New York market last year was 7½ cents per pound, or about $160 per ton, and one manufacturing company consumed during the year over thirty million pounds. This was chiefly manufactured into cordage.

The many species of Yucca flourish throughout the Southwest and in many portions of tropical and semi-tropical America. Good fiber can be produced from the plants, and machinery has been invented for the purpose of separating it. Not having seen the machine I cannot say how successfully it accomplishes its work, or what are the drawbacks to the production of Yucca fiber as an industry. I have seen a number of yucca manufactures, and find them good, and the fiber admirably adapted to the purposes for which intended. Among the samples are specimens of yucca cordage and coarse "cloth" (matting) from *Y. filamentosa*, manufactured by Mr. Stoner, of Stony Point, Louisiana. What has been said regarding the market for Sisal will apply equally well to the yucca fiber. The two forms of fiber are very similar. In fact, small portions of yucca occasionally find their way to market from Yucatan, mixed with Sisal, and of course sold as Sisal. This fact is mentioned in the body of the report and the differences in the two fibers pointed out.

The following statements are made in a communication received from Mr. Stoner, the inventor of the Yucca machine mentioned above:

> I have cultivated, tested, and manufactured to some extent the Yucca *filamentosa*, and *Aloefolia*. The fiber can be readily obtained by means of machinery, by which the green leaves are thoroughly mashed, and then passed through a system of washing which removes all extraneous substance, leaving the fiber as white as Irish linen, and ready for market. The entire southern portion of the United States is peculiarly adapted to the natural growth of fibrous plants, but the hinderances [to their successful production] are three-fold. First, the Southern people are very reluctant to take hold of anything new, and especially any agricultural product except cotton; second, they are no manufacturing people; and, lastly, the financial and political conditions are not favorable. I sincerely believe that if some wealthy and energetic manufacturing company would take hold of the Yucca cleaning machine, or any other that would clean the fiber, and introduce them in the South, they would soon become as numerous as the cotton gin, as there are thousands of tons of yucca in the South now ready for utilization.

Not to put it quite as strongly as our correspondent, I think that with capital at hand any individual or company could make money in Texas, or in the territory where the yucca abounds, by establishing mills, for the supply is almost inexhaustible, and the fiber would certainly command as ready a market as Sisal. Some of our large eastern manufacturing firms might find it advantageous to make the experiment, and if it resulted in the finding of a home supply of cordage material the nation, as well as themselves, would reap the benefits of the new industry. The fiber of *Agave Americana* or "pita" deserves to be brought into notice as a valuable cordage material. Two patents have been granted within a year or two for machines for its production.

Among other fibrous products received in reply to the circular sent to manufacturers were samples of the bagasse of sugar-cane and a series of the products derived from it for paper manufacture. The raw product is obtained at the mills (Louisiana sugar plantations) at about $15 per ton, or three-fourths of a cent per pound. The bagasse from Louisiana cane is considered superior to that from the West Indies, from the fact that it never reaches its real state of maturity, while the latter is not used until quite ripe. The matured fiber is coarser and less flexible and strong.

Before closing this category of new fibers it will be well to mention a New Jersey industry, quite limited in extent, which is a source of considerable revenue to those engaged in it. It is the gathering of the fiber from the brown heads of the cat-tail flag, *Typha latifolia*. The New Jersey swamps abound with this reed, and in the fall large quantities of the "fiber" are gathered by men and boys, to be sold in the New York market for upholstering purposes. Its chief use is as a substitute for feathers in the manufacture of pillows, the finest "fiber" bringing often $60 per ton. The collector, as he should be called, goes into the field or swamp armed with a large bag; at his side he carries a little pronged instrument, by means of which the fluffy mass of fibrous material or "down" is stripped from the stalk as the operator passes the head of the reed through it. The heads must be fully mature, and then the material comes off without trouble, falling into the open mouth of the bag as the operator walks along. There are several grades of "fiber," some of them "fancy," bringing extra prices. I am informed that a fiber is also produced from the stalk of this flag, though I was unable to learn anything definite concerning it.

FIBER MACHINERY.

We cannot leave this report without a brief reference to some of the improved machinery now available for the preparation of flax, hemp, ramie, and other fibers. Some forty-five patents have been granted in the last five years for improvements in machines for cleaning, preparing, and manipulating vegetable fiber, exclusive of cotton, a list of which, with names of inventors and dates of issue, are given in an appendix to this report. As but a few of these can claim our attention, only the most important will be named, together with several standard machines for especially preparing flax and hemp.

Flax and hemp machinery has been treated so fully in Mr. Proctor's late work, issued by the geological survey of Kentucky, that I take pleasure in referring to its pages those desiring more complete descriptions than can be given in this brief report.

Two forms of machines are used by those cultivating small areas or making flax cultivation a secondary matter of farm practice. The first of these may be described as a revolving brake with rollers six inches in diameter. These may be of cast iron with flutes, or of hard wood with surfaces fluted, or of wood with ridges of iron screwed on. Slots in the frame work, 3 or 4 inches long, allow sufficient play for the bearings of the upper roller. The pressure is given by attaching heavy weights to poles which rest upon the gudgeons of the upper roller, supported by bands of iron which pass over them. The driving pulley is connected with the lower roller. In this machine the straw is passed through the rollers several times until sufficiently broken.

The second machine is of English manufacture, and is similar in construction, but more powerful. There are two pairs of fluted rollers, the

first pair drawing in the flax and passing it to the second pair, the flutings of which are finer. The bearings work in slides so as to adjust themselves to the varying thickness of straw, and the pressure is obtained by means of rubber rings placed in recesses on the top of the sliding bearings, being kept in place by cross-bars. The straw is passed but once through the machine, the successive crimping and breaking separating a considerable portion of the woody part, which drops from the machine, while the more tenacious fiber passes on. Such a machine is said to cost in New York, freight and duty included, about $155. The driving of the top rollers is accomplished by means of gearing, and not by contact with the lower roller, as in the previous machine. This system insures better fiber, as it is not liable to injury or deterioration caused by the grinding action of the flutes in the simpler machine.

There is a larger machine, suitable for scutch mills, breaking, &c., which, it is claimed, is better for both flax and hemp. In this machine there are three pairs of fluted rollers, and endless feed and delivery aprons. The refuse is brought by a shute to the front of the machine below. There is a reciprocating motion attachment to the machine, which causes the rollers to revolve in a forward direction for a given time, and then to reverse the motion.

The flax or hemp straw on entering the machine is subject to a forward and backward motion, the former always being in excess of the latter, so as to cause the straw to pass gradually through the machine. The production of the machine is reduced by the application of this motion; but its breaking and bruising action on the straw is greatly increased. This motion is very beneficial in all cases in which the straw is of strong growth and coarse, requiring much breaking preparatory to scutching.

The brake best known in the United States and Canada is the Mallory and Sandford machine. It is made in different sizes, the illustration being taken from a six-roller brake, with rolls 3 inches in diameter and 30 inches long. It cleans the fiber very thoroughly, and it is claimed that less power is required than in any other machine. It takes out more of the woody and worthless portions of the straw, and wastes less fiber.

A committee of the New York Agricultural Society made a series of experiments with this machine, by which it was found that—

The average work of the machine during the three trials was 1.558 ounce per second, which at 10 hours work per day would be equivalent to 2,668 pounds of flax straw. The total weight of broken straw in three experiments was 20 pounds 10 ounces, which was scutched in 23 minutes and 50 seconds, which is equal to 0.772 ounce per second. Running 10 hours, a scutching machine will dress 1,737 pounds of broken flax straw.

The machine patented by Norbert de Landtsheer, of Paris, France, May 8, 1877, may be called one of the most recent additions to flax-cleaning machinery. It is provided with a combination of fluted rolls having a double-reciprocating motion, with a scutching drum composed of two rings of cast metal, covered with sheet metal, on the circumference of which are attached eight, twelve, sixteen, or even a larger number of blades, if desired. These blades beat the material as it is delivered from the fluted rolls. As the ends of the material being cleaned or scutched are first treated, it will be evident that the portions separated from the material by scutching will be scutched also. The products obtained will thus consist of long-stapled material, more or less perfectly scutched, as well as a long tow, which is also scutched. In this manner great advantages are claimed to be obtained over other systems. The scutching may be done in this machine by inexperienced hands, or by women or boys, which is an advantage in places where skilled labor is scarce and growers are prevented from raising such quantities of flax

as they otherwise would. The action of this machine is such that the ends of the straw are first operated on, and so on to the middle of its length, whereby a better and larger product of long-stapled scutched fiber is obtained, while the value of the tow obtained is more than double that produced in scutching generally.

An improved machine like the foregoing is calculated to give increased impetus to the culture of flax, which will lead to the cheapness of the raw material, with increased profit not only to the grower but also to the manufacturer, as the cost of breaking and scutching on this improved system is claimed to be about one-third less than upon ordinary machines.

A committee on science and arts of the Franklin Institute, Philadelphia, after satisfactory experiment, say of this machine:

> *This mechanical contrivance is deserving of special mention, being well adapted for the purpose designed*, is capable of adjustment to suit different lengths of fiber, and may be controlled automatically or by hand. The flax stalks operated upon were grown, not for the fiber, but for the seed alone, and had not been properly "retted," yet the machine under consideration performed the operations of breaking and scutching with entire success. Flax stalks two feet and hemp stalks eight feet long were alternately fed to the machine, and the fiber was delivered clear of "boon," straw, and woody material, in from thirty to forty seconds, while but little scutching tow or codilla was made. The introduction and general use of this machine would, without doubt, tend to restore and extend the cultivation of such fibrous plants as flax, hemp, jute, and others of a similar nature, by enabling producers to deliver these several fibers in a clean, straight, long line, and marketable shape, at low cost.

A hemp-hackling machine, the invention of Theo. Tebow, of Frankfort, Kentucky, was patented in May, 1879, which claims to hackle a large amount of material at one time. The patentee claims the following advantages for his machine:

> The bunch of material to be hackled by the machine is from one hundred and sixty to two hundred pounds in weight, while about two pounds of the material is usually the amount taken by hand, it requiring, of course, a few more passes of the hackles through this material when operated upon in the machine than it does by hand; but the movement of the hackles is so rapid that the time occupied in dressing a single bunch by machine is less than required in hand-work.
>
> A very material advantage resulting from the use of the machine is avoiding the breaking of the fiber consequent upon the short stroke of the hackles, which can work upon the bunch inch by inch, leaving the fiber in better condition than by hand-dressing and producing much less tow.

The latest invention in vegetable fiber machinery is that of Mr. A. Angell, of Newark, N. J., for the cleaning of ramie and other vegetable fibers of like nature. It was only brought to public notice late last season, having been patented in November. It has already been placed in the hands of practical business men to be manufactured, and by them will be taken to India to compete for the £5,000 price offered by the government at Calcutta, for a successful ramie and jute cleaning machine. The machine is thirty-four inches wide and forty-two high, and is very strong and apparently not liable to damage. It can be removed to any point without taking apart, and it is ready for use on the instant, being simply a series of rollers and scrapers and beaters. At the top is a hopper with a dozen holes, through which the fiber is fed to the machine. The machine started, a stalk of ramie or other fiber is set by the thick end into the hole; it is grasped between two rollers, covered with flexible rubber, and the stalk, in passing into the machine, immediately encounters a knife, which splits it in two, sending the two halves to opposite sides of the machine. The halves on their journey encounter "beaters," which break off the pith and wood, and on the other side encounter "scrapers," which remove the bark, and in an instant the filament comes out in long ribbons of fiber. An unbroken ribbon, ex-

actly the length of the stalk or switch which was fed to the machine is thus obtained, and the wood and extraneous matter are as cleanly taken off as could be desired, and without slivers.

It is claimed that the stalks of ramie, mallow, or jute may be run through the machine the moment they are cut, without waste of time by preparatory rotting of wood or outer bark, which injures the fiber. Further, that there is absolutely no preparation at all, and the fiber is unbroken. The scrapings of bark, &c., can be used in paper-stock, while the woody matters can be used for fuel for the engine driving the machine. The only remaining process is to boil the gum from the ribbons of fiber, and they are then ready to be tied in hanks for the rope-walk, or for the manufacturer. The machine is said to clean or prepare 2,000 pounds of fiber per day, fed by a boy, the stalks being placed upon a platform within easy reach. The boiling is a simple matter and can be done in the field, or factory, or shed where the machine is running, or the ribbons may be marketed as they come from the machine, the cordage manufacturer boiling out the gum at the same time that it is boiled for bleaching.

In the patent specification it is stated that—

This invention consists in the combination of feed-rollers, a splitting-knife, a series of separate channels, each adapted to receive and guide the two halves of a stalk of ramie or other fibrous plant, and crushing rollers, which receive the split stalks from the guide-channels for breaking the connection of the fibers with the pith and skin. A beater, which acts on the split stalks as the same pass from the crushing rollers, serves to detach the pith from the fibers, and the skin is finally removed by the action of a grinding surface. On the splitting-knife are secured suitable cams for turning the upper half of the split stalk, so that both halves pass through the crushing rollers with the pith side facing upward.

The yucca machine, to which reference has been made (A. Stoney's patent, May 7, 1876), consists of two horizontal cast-iron rollers, twelve inches in diameter, twenty inches long, cast hollow with one inch shell. The surfaces are smooth and the rollers set true, so as to thoroughly mash or crush the green glutinous mass loose from the fiber of the yucca blade. It is provided with two-inch journals 6 inches long, to admit of the necessary pulleys, propelled by cog-wheels on one end. The top roller, adjusted by set-screws or springs, makes about 40 revolutions per minute. Above the crushing rollers is arranged a sprinkling device, that is made of two horizontal pipes, perforated at the bottom, and of a cross-pipe connected with the supply-pipe. These furnish a supply of water in jets to both sides of the crushing rollers, for the purpose of softening the green extraneous matter as it passes the crushing rollers and brushing cylinders. Steam may be used in place of water, where it is not convenient to use the latter. The brushing cylinders, of which there are three, vary from 3 to 5 inches in diameter, are twenty inches long and are thickly set with best English steel-wire, untempered, projecting from one-fourth to one-half inch from the surface of the cylinders. The green yucca leaves are carried to the crushing rollers by means of an endless apron or feed-belt four feet long and twenty inches wide, conveyed upon two wooden rollers, propelled by pulley and strap connection with the journal of the lower crushing roller.

The patentee writes that for want of means to push it, but little has been done with the machine other than in an experimental way. The machine has also been used to clean ramie stalks.

In November, 1877, a patent was granted to Carlos de la Baquera, of New York City, for a machine for the extraction of the fiber from the leaves of the *Agave Americana*, known as "pita." Having only seen the patent specification, and being unable to learn anything about the ma-

chine from other sources, I can give no statements as to its merits. The appliance consists in a scutching and hackling wheel, corrugated rolls, and a wheel carrying several series of tools, each consisting of a steel wire brush, a scutching blade, and several hackling combs, with other appliances for cleaning the fiber from the extraneous matter of the leaf. After running one end of the leaf to be operated upon, through the breaking rolls, it goes to the scutching blades and hackling combs, the wire brush effectually removing the outer coating of the leaf, and also the pulp, and separates from the refuse matter the fiber in a clean, unbroken mass. When one end of the leaf has been treated, it is reversed and the other end treated in the same manner.

A machine similar in principle, and for the same purpose, was patented in November of last year by Pedro Sanchez, of Tabasco, Mexico.

An "istle" machine, intended to facilitate the slow and primitive process of obtaining the fiber of *Bromelia sylvestris* by hand scraping, was patented in January, 1876. Its inventor is Guillermo R. Welke, of Parras de la Fuento, Mexico.

The invention consists mainly of devices for scraping the leaves, while being drawn by rollers through the scraping knives, which are made to yield to the thickness of the leaves. The leaves are placed between the scrapers up to the gage-piece, and then carried with the scrapers toward the feeding rollers. Sliding and reciprocating scraper-jaws are operated by suitable transmitting mechanism, by the forward motion of the scraper frame, for scraping off the ends of the leaves, which are conveyed to a receiving platform, and dropped by the same into a receptacle below.

The patentee claims that previous to the invention of the machine in question, all the fiber of "istle" produced—great quantities of which are annually consumed—was prepared by hand.

While upon this subject, it will be well to mention an improved process for disintegrating the stalks of hops, a patent for which was issued to Isaac N. Nördlinger, of Stuttgart, Germany, September 4, 1878. The object of the invention was the production of fiber adapted for spinning purposes, from hop stalks, which have been considered worthless. The fiber is said to be long and fine and can not only be used as an upholstering material, but also with great advantage for spinning and weaving. The product resembles flax fiber very closely, and its inventor claims that "in respect to elasticity, softness, and durability it is superior to all other fibrous materials, such as nettle fiber" and those of a similar nature. It is also said to be cheaper. The process is a boiling and chemical treatment of the stalks of the hop plant.

SUMMARY.

In conclusion, it would appear from all that has been advanced upon the subject that these fiber products still occupy a recognized position in American agriculture; that, notwithstanding many adverse influences, causing serious fluctuations and irregularities of production, they still engage active attention. That their production may be extended in the future there are no doubts. It is evident, however, that old systems must be discarded, for the spirit of the age is a spirit of progress. The successful farmer of the future must keep up with the times, calling to his aid the experience of the world around him and such helps as inventive genius and the necessities of the times may bring forth.

The flax industry, it might be supposed, should be prosperous. However flourishing the cotton industry, there is room for flax. The demand for oil renders imperative its growth; the need of oil-cake in foreign meat production is a governing force in its cultivation; the cattle-feed-

ing business in this country is beginning to enforce a similar necessity, which will ultimately prove more controlling. The drain of more than twenty million dollars per annum for flax products of foreign countries during the last decade is also a strong argument for the extension of flax production.

There is no insuperable obstacle to the supply of all demands for fine linens, though the climate of a part of the country is less favorable to the growth of fine fiber than that of the moist climate of Ireland and Holland. Northern New England, New York, the lake region, and especially Oregon and Washington Territory furnish suitable climatic conditions. The labor question is one requiring time for its solution. With much diversity of cropping, so frequent calls to apparently more profitable rural employment, there is little opportunity here for development of skill which exists in so high a degree in certain flax-growing districts of Europe. Gradually, as population crowds and labor competes, the growth and manipulation of fine flax fiber will command the economic faculty and inventive genius which give the American laborer an advantage in every serious effort to compete with the skilled and low-priced labor of Europe. The time will be quite sure to come when the production of fine fiber will be immensely enlarged, and it would be wise in the national government to foster and encourage such development.

Meanwhile the cultivation for seed, for oil and cake, though subject to fluctuation, to changes from one district to another, is extended and must continue such extension. There is one obstacle to success, which alone prevents an immediate and rapid growth—a large portion of the flax-straw is now wasted. Here and there a mill for the manufacture of tow takes all that is offered in the neighborhood, while large areas have no mills within hauling distance. It is needed for paper stock, for upholstering uses, and especially for baling of wool and cotton, and bagging for grain. It is understood that nearly a million cotton bales are enveloped in flax bagging, of the more than five millions grown and packed, the remainder being mostly made in this country from the fiber of jute butts, a foreign product that drives the native material from the field. Ten years ago the importation of this material was 17,549 tons; now 69,590 tons. Then the importation of cloth for bagging was 11,486,005 pounds; now but 2,856,195 pounds. The cause is apparent. The manufacturers of jute bagging at the sea-ports have large capital, organization, and all facilities, with the low duty of $6 per ton, little more than one-fourth of a cent per pound, and a lower price for material than ten years ago, which was last year less than 3 cents per pound. So the interior flax mills are driven to the wall. They say, "Give us a higher duty on jute butts, and we will furnish all the bagging for cotton, and wool, and grain, from material which is now wasted, and we will do it on an enlarged scale, at the price which the jute bagging now commands." This would lead to a great increase in area of flax, would make prosperous a prominent agricultural industry, and prove a source of wealth to the western farmer, who claims that he is entitled to a little protection as well as the manufacturer.

On the other hand, the jute manufacturer claims that it is the true national economy to admit raw material duty free, and so encourage the manufacture of bagging instead of importing that made by foreign labor.

The western flax miller and flax grower replies, that if it is good to give employment to American labor in manufacturing bagging: it is better still to give further employment to American labor in growing the raw material.

So a conflict rages between jute and flax, and so evenly balanced are the forces, that flax is able to compete for a portion of the cotton baling; yet jute has a slight preponderance, perhaps altogether due to the advantage of larger capital, and better organization and division of labor, and therefore the jute manufacture is successful, and flax milling comparatively depressed. It is a conflict between the seaboard and the interior; between the heavy manufacturer on the one side, and the small manufacturer and the farmer on the other. The flax men have logically the better position, if they can make good the promise of a full and cheap supply; the jute men have the advantage of having produced substantially a supply, while it is not proved that their opponents are able to make good their promise.

Hemp culture may likewise be extended, for with the demand for finer grades of fiber for spinning purposes, for twine, for grain binders, and for cordage, the States at present producing it will hardly furnish a supply. As in the culture of flax, however, better methods must be adopted, and more careful treatment given the crop, that it may, in one sense, make its market through superior quality.

APPENDIX I.

THE CULTIVATION OF *ABUTILON AVICENNÆ* IN NEW JERSEY,* WITH LETTER OF PROF. SYLVESTER WATERHOUSE.

In the general development of the fibrous industry, we have made very decided progress this year. There really need be no difficulty in growing jute-producing plants,† the material point being to ascertain the best conditions under which to convert hitherto uncultivated plants into those of future industrial significance and profit. Any experienced farmer, from his observation of these self-propagating "weeds," can as readily achieve good results in their cultivation as he can in his first attempts at growing for profit peaches, pears, grapes, or any other untried crop. He has a general knowledge of their requirements, and his success at the outset will be in proportion to his professional knowledge and theoretical dexterity. There being no question respecting the cultivation of jute, the remaining problem concerns the obtaining of the fiber from the bark, and the industrial purposes of which it is susceptible. Jute, in its ordinary marketable condition, is chiefly adapted to coarse but useful fabrics and cordage, but through the appliances of skill and science, it has unquestionably a range of uses still to be discovered, and it is our aim to discover these hidden qualities.

In all our efforts to promote the fibrous industry, we have had the intelligent co-operation of Mr. Lefranc. He has given his whole attention this summer, at Camden, to the discovery of new methods of treatment of the outward coating of the plant, with a view of imparting new value to the fiber derived from it. These efforts are in harmony with the widely extending conviction that the highest industrial progress which this nation is destined to achieve is inseparable from the utmost diversity of industries, and an augmented proportion of skilled and artistic pursuits to the unskilled. In pursuance of this idea, Mr. Lefranc confidently believes he has discovered a combined chemical and mechanical process, by which the intrinsic and industrial value of jute can be greatly enhanced, at comparatively small cost. * * * If this newly discovered property in domestic jute (*Abutilon avicennæ*) is confirmed by subsequent experience, it will impart an unanticipated significance to the fiber industry throughout, since ramie and the whole range of developed and undeveloped long staples can be brought under the same treatment with like results.

We feel assured that the steeping or retting process, which, until quite recently, was deemed indispensable, has been overcome, and that in growing these products the labor of the farmer will thereby be greatly diminished, and only equivalent to that incident to the growth of wheat and rye. Sowing, cutting, and carting in the green

* From the Second Annual Report of James Bishop, chief of bureau of statistics, labor, and industries, of New Jersey, for the year 1879.

† Plants bearing a fiber similar to the jute of commerce (*Corchorus*), which may be used as a substitute in this country for that fiber.

state, at present, seems to be all the farmer will have to do. If he can be saved the trouble and expense of preparing pools for steeping, as is done in India in respect to jute and ramie, and in Europe and Ireland in respect to flax, and two or three handlings and cartings besides, he will have gained a very material advantage in the cost of those domestic products.

We have known for some time of an ingenious mechanical contrivance in Newark for extracting fiber from the various fibrous plants we are endeavoring to introduce into our State. This machine is the invention of Mr. A. Angell, and we have no hesitation in saying that it has achieved such results as to entitle it to public recognition as being in the line of devices for promoting the fibrous industry. Success in this new industry, as we have many times stated, and which daily becomes more obvious, is dependent upon the best mechanical attainments in separating the bark from the wood, and in the subsequent manipulation of the fiber for market. Hence it is incumbent upon us to acquaint the public with whatever comes to our knowledge respecting progress in the development of this important industry.

The normal length of fibers destined for the loom is of no special moment, since it is well understood that for spinning purposes the very long class of fibers require to be subjected to a process by which they may be assimilated to cotton and wool; therefore, the means by which they can be brought into the spinning state with the least injury to the fiber will necessarily be adopted. The two gentlemen we have referred to are sedulously engaged in efforts to solve the remaining problem respecting the production of domestic fibers. They have both succeeded in furnishing products which have elicited the deepest interest on the part of consumers, who stand ready to use New Jersey jute and ramie whenever they can be supplied. Hitherto both of these products, for the most part in all countries, have been woven into fabrics of various grades; but there is reason to believe vast quantities of jute, especially, will be consumed for cordage, bagging, matting, and other long-staple purposes, in this country, as soon as the raw materials are grown here.

The writer has interviewed several large importers and consumers of all kinds of hemp, jute, sisal, and flax, and but one opinion was expressed respecting the prospective industrial value of the New Jersey products exhibited, conditioned of course, upon their relative cost to those already in use. We were likewise assured that the consumption of this and kindred fibers is practically limitless under such conditions as to cost and quality as present attainments in domestic culture seem to indicate and verify.

WASHINGTON UNIVERSITY, *Saint Louis, Mo., October* 20, 1879.

DEAR SIR: Recent investigations enable me to make a prompt response to your inquiries.

The *Abutilon avicennæ*, the cultivation of which you have so forcibly recommended, seems susceptible of development into a source of public wealth. The plant grows throughout the West in rank and wild luxuriance. It has the spirit and capacity of conquest. With invasive march it has taken possession of large tracts of land. Its tenacity of life and rapid spread render its cultivation a far easier task than extermination. There are to-day, in the suburbs of Saint Louis, stalks of abutilon 8 feet in height. It is claimed that the fiber is superior to hemp in whiteness, strength, durability, and cheapness of production. Unlike Indian jute, abutilon needs no naturalization. To the manor born, it exhibits a stubborn determination to occupy its heritage.

Why is not this plant utilized? If it grew in France, the French Government, ever sagaciously watchful for new sources of public wealth, would encourage its cultivation by the offer of liberal bounties, and stimulate inventors to the discovery of the best process for treating the fiber by prizes generously proportioned to the magnitude of the interest. A policy which has so effectively developed the textile resources of France would, presumably, be alike beneficial to the manufacturing industries of the United States. If personal wishes could control legislative action, my own State would anticipate New Jersey in the adoption of this policy.

The offer of bounties in a country which throughout its history has fostered domestic industries by the protection of a tariff assuredly needs no defense. If it be wise to discourage the importation of foreign products by means of a tariff, certainly it cannot be impolitic to develop native substitutes by the bestowment of bounties. Even if individual enterprise would ultimately accomplish the result, the patronage of the State would secure its earlier attainment. Our legislature can well afford to encourage experiments whose success would enrich the nation. The expenditure of a few thousand dollars may bring a return of many millions.

The jute crop of India is now about half a million tons, worth at least $[illegible]0,000,000; and the cost of the foreign fibers annually imported into the United States is more than $[illegible]0,000,000. If any considerable portion of these larger values can be created and

saved by domestic growths, the undertaking would seem to be especially worthy of legislative patronage.

In respect to bounties, it would appear to be just and proper that they should be so dispensed as to reward both the farmers who grow the plant and the inventor of the best process for disintegrating and preparing the fiber for market. The old system of manual treatment is too slow and costly. Unless the fiber can be quickly and economically prepared, by chemical or mechanical processes, the cultivation of abutilon must prove a failure. At the present moment our great need is a cheap and effective method of separating the fibrous from the ligneous part of the stalk. With the high prices of labor in this country, no manual preparation of the fiber can successfully compete with the cheap handwork of India.

The cleaned specimens of fiber you sent me are excellent, and indicate a good degree of progress in the treatment of fibrous products. The inventor of a cheap and rapid means of disintegrating the fiber of hemp, jute, ramie, abutilon, and the allied mallows will not only secure a fortune for himself, but will also enjoy the rare distinction of having created a new and valuable industry. Such an inventor would be the Whitney of another development in textile wealth. It is a reproach to American ingenuity that an industry which in India ranks as fourth in productive value should be so insignificant in the United States. It is indeed surprising that the inventive genius of our countrymen, which has achieved such splendid triumphs over greater difficulties, does not address itself to the solution of a problem so rich in possible results.

Every forward movement in the diversification of our productions is an advance towards an industrial independence of the whole world; a variety of industries is a basis of self-reliance, a source of national wealth, and a safeguard against commercial depression. The agricultural and mechanical arts tend to strengthen each other and to preserve communities from a general prostration of business interests. One of the prosperous results of a cultivation of abutilon and ramie would probably be a revival in the culture of flax and hemp. Fabrics designed for certain commercial uses are improved by a combination of their fibers with jute, and consequently an extensive employment of the one will imply an increased demand for the others.

Jute is too bulky for distant transportation. The freight would consume the profits. Factories for the separation of the fiber should be erected in the neighborhood of production, where the abutilon, rose mallow, and other similar plants, which can be so easily raised, would apparently, even at present market rates, yield the farmer a profitable return for his labor.

The foregoing remarks apply more particularly to the cultivation of domestic jute in the North. But I have not at all relinquished my belief in the possibility of naturalizing Indian jute in the South. The conditions of success must be determined by experiment. Many trials will result in failure. But ultimately the essential conditions of soil, climate, and moisture will be ascertained, and then the growth of native and naturalized jute, aided by proper mechanical appliances, will add to the wealth of the country a new textile resource scarcely inferior in importance to cotton.

Respectfully, yours,

S. WATERHOUSE.

SAMUEL C. BROWN, Esq.,
Secretary of New Jersey Bureau of Statistics.

APPENDIX II.

AN ACT TO ENCOURAGE THE PRODUCTION AND TREATMENT OF FIBERS IN THE STATE OF NEW JERSEY.

The following is a draft of the bill presented at the last session of the legislature, in the senate, by Mr. Bodine:

Whereas there are ample assurances that the soil and climate of this State are adapted to the cultivation of jute, ramie, flax, hemp, and various other fibrous plants and grasses which are extensively grown in other countries, and largely imported into the United States; and whereas the development of new productive industries are of essential benefit to the public welfare; therefore,

Be it enacted by the senate and general assembly of the State of New Jersey, That, with the view to stimulate individual effort in the cultivation of fibrous plants, the treasurer of this State be hereby authorized to pay the following bounties, upon vouchers duly receipted by the payee, setting forth the quantities and prices of the products grown by him or them, whose affidavit of their truthfulness shall first be affixed to

the said vouchers, and be attested by the clerk of the county in which the products are grown; and, moreover, the said vouchers shall be certified by the chief of the bureau of labor and industries of this State:

I.—JUTE.

For every ton of two thousand pounds of abutilon avicennæ stalks grown in New Jersey not less than three feet long, five dollars; for every ton of two thousand pounds of what is known as rose or marsh mallow not less than three feet long and not more than one inch in diameter at the butt, five dollars; fractions of not less than a quarter ton in each case will be paid for at same rate; for every pound of marketable quality of disintegrated jute, two and a half cents.

II.—RAMIE.

For every two thousand pounds of ramie stocks not less than two and a half feet long, ten dollars; fractions of not less than a quarter ton will be paid for at same rate; for every pound of disintegrated ramie ready for combing, five cents; for every pound of ramie yarn ready to weave, ten cents.

III.—FLAX.

For every ton of two thousand pounds of flax stalks for fiber of the ordinary lengths, seven dollars; fractions of not less than a quarter ton will be paid for at same rate; for every pound of decorticated or cleaned flax of first American quality, three and a half cents.

IV.—HEMP.

For every ton of hemp stalks of two thousand pounds of the ordinary lengths, six dollars; fractions of not less than a quarter ton will be paid for at same rate; for every pound of decorticated or cleaned hemp of best American quality, three cents: *Provided*, That the bounties hereby authorized shall cease on the first day of April, one thousand eight hundred and eighty-five: *And provided further*, That in no event shall the total amount expended in the form of bounties under this act exceed the sum of fifteen thousand dollars, to be apportioned as follows: five thousand dollars to be awarded to the enumerated stalks, five thousand dollars to the enumerated cleaned fiber, and five thousand dollars to the ramie yarn.

And be it further enacted, That it shall be the duty of the chief of the bureau of labor and industries to certify the vouchers referred to in the first section of this act, and to have general supervision, control, and decision of all questions which may arise pursuant to the provisions of this act.

And be it enacted, That the treasurer of this State is hereby authorized to pay any money in the treasury not otherwise appropriated in pursuance of the provisions of this act.

And be it enacted, That this act shall take effect immediately.

APPENDIX III.

LIST OF PATENTS FOR FIBER MACHINERY AND PROCESSES.

The following is a list of patents granted during the past five years—January, 1875, to December 31, 1879—for inventions for obtaining and preparing fibrous substances other than cotton and wool, with name of inventor and date of issue:

Improvement in machines for combing and cutting grass and bristles. Patent No. 158650. Granted to Joseph Pickering, of Philadelphia, Pa., January 12, 1875.

Improvement in processes of making paper-pulp from palm. No. 6646. Reissued to James P. Herron, of Washington, D. C., June 2, 1875.

Improvement in hemp and flax machines. No. 165826. Granted to Christopher Herrschaft and James Lawrence, of Brooklyn, N. Y., July 20, 1875.

Improvement in processes of treating rattan. No. 167409. Granted to Carleton Newman, of San Francisco, Cal., September 7, 1875.

Improvement in machines for dressing tampico. No. 171080. Granted to J. D. Baker, of Burlington, Vt., December 14, 1875.

Improvement in hemp-hackling machines. No. 170947. Granted to Frederick D. Frost, of London, England, December 14, 1875.

Improvement in processes for preparing vegetable fiber for upholstering. This relates to the preparation of palmetto fiber for filling mattresses, and for other purposes. No. 668. Granted to James L. Cutter, Brooklyn, N. Y., December 21, 1875.

Improvement in istle machines for producing the fiber of *Bromelea sylvestris*, applied in Mexico to the manufacture of hammocks, sacks, ropes, nets, cotton-bagging, wagon sheets, carpets, and similar objects. No. 171708. Granted to Guillermo Roberto Welke, of Parras de la Fuento, Mexico, January 4, 1876.

Improvement in flax and hemp machines. No. 172519. Granted to John Stewart, of Brooklyn, N. Y., January 18, 1876.

Improvement in ramie machines. This machine is intended to prepare the fiber of ramie, flax, and other textile substances directly from the dry stock, so that it shall be presented in marketable form by one single operation. No. 172610. Granted to Charles C. Coleman, San Francisco, Cal., January 25, 1876.

Improvement in hemp and flax brakes. No. 178110. Granted to Luther E. Burdin, Paris, Ky., May 30, 1876.

Improvement in machines for separating the fiber of ramie and other fibrous plants. No. 181382. Granted to John B. Vogel, of New York, August 22, 1876.

Improvement in machines for dressing and combing tampico and bristles. No. 184940. Granted to Enoch B. Whiting, of Saint Albans, Vt., November 28, 1876.

Improvement in tampico combing and dressing machines. No. 184943. Granted to George Willett, Burlington, Vt., November 28, 1876.

Improvement in machines for cutting fibrous material. This machine is intended to cut thin shavings of wood for stuffing mattresses for dyeing, &c. No. 184912. Granted to James Langster, Buffalo, N. Y., November 28, 1876.

Improvement in processes of softening, decolorizing, and cleansing animal and vegetable fiber. No. 187882. Granted to William Maynard, of New York, February 27, 1877.

Improvement in processes of manufacturing paper-pulp from the fiber of *Abuliton avicennæ*. No. 196666. Granted to Douglas Hickox, Springfield, Ill., October 30, 1877.

Improvements in machines for treating flax, hemp, and other similar plants. No. 190476. Granted Norbert de Landtsheer, of Paris, France, May 8, 1877.

Improvement in flax brakes. No. 197063. Granted to John H. Tabler, November 13, 1877.

Improvement in machines for extracting the fiber of pita (*Agave Americana*). No. 197555. Granted to Carlos de la Baquera, of New York, N. Y., November 27, 1877.

Improvement in apparatus for digesting and macerating fibers by chemical reagents. No. 197850. Granted to William W. Harding, of Philadelphia, Pa., December 4, 1877.

Improvement in machines for polishing vegetable fiber, for use in the brush-making trade. No. 198315. Granted to George Shaw and Thomas Shaw, of Dukinfield, Great Britain, December 18, 1877.

Improvement in machines for treating palmetto leaves, &c., for upholstery purposes. No. 201269. Granted to George F. Miller, Jacksonville, Fla., and W. G. Benedict, Orange Park, Fla., December 27, 1877.

Improvement in the manufacture of paper pulp from salt water fibrous plants. No. 199427. Granted to William E. Farrell, of Philadelphia, Pa., January 22, 1878.

Improvement in treatment of cocoa-nut fiber, for manufacture of various useful products. No. 202662. Granted to Eug. Pallu, of Paris, France, April 23, 1878.

Improvement in separating wool and cotton, and similar animal and vegetable fiber, from fabrics. No. 202672. Granted to John Y. Slater, Baltimore, Md., April 23, 1878.

Improvement in machine for making fiber from palmetto leaves, for upholstering purposes. No. 202766. Granted to Lucius P. Summers, of New Britain, Conn., April 23, 1878.

Improvement in treating palmetto fiber for use in the arts. No. 203177. Granted to George F. Miller, of Jacksonville, and W. G. Benedict, of Orange Park, Fla., April 30, 1878.

Improvement in machines for preparing yucca fiber. No. 203386. Granted to A. Stoner, of Stony Point, La., January 29, 1878.

Improvement in fiber-cleaning machines. No. 204906. Granted to George D. Luce, of New Orleans, La., March 2, 1878.

Improvement in preparing palmetto fiber and pine leaves for mattress fillings. No. 205035. Granted to Washington G. Benedict, of Orange Park, Fla., June 18, 1878.

Improvement in hemp and flax brakes. No. 205910. Granted to Gelston Sanford, of Brooklyn, N. Y., July 9, 1878.

Improvement in fiber machines. No. 205911. (Same name and date as preceding.)

Improvement in processes for disintegrating the stalks of hops for fiber. No. 209286. Granted to Isaac D. Nördlinger, of Stuttgart, Würtemberg, Germany, October 22, 1878.

Improvement in separating and cleaning vegetable fibers for paper pulp. No. 210339. This refers to the fibers of sugar-cane, sorghum, and Indian corn. Granted to Charles Lauga, New Orleans, La., November 26, 1878.

Improvement in separating animal from vegetable fibers. No. 211100. Granted to George M. Rice, Worcester, Mass., January 7, 1879.

Improvement in machines for dressing hemp, flax, &c. No. 215692. Granted to Theodore Tebaw, of Lexington, Ky., May 20, 1879.

Improvement in the manufacture of paper pulp and paper from grasses. No. 218324. Granted to Adolph Seyler, of Brooklyn, N. Y., August 5, 1879.

Improvement in processes and machines for disintegrating ramie and other fibrous plants. No. 219668. Granted to Albert Angell, of East Orange, N. J., September 16, 1879.

Improvement in machines for cleaning and extracting fiber from fibrous plants, and especially the leaves of pita (*Agave Americana*). No. 221365. Granted to Pedro Sanchez, of Tabasco, Mexico, November 4, 1879.

Improvement in the treatment of pine leaves for the manufacture of paper, and for other purposes. No. 221687. Granted to Albert W. Maas, of Meriden, Miss., November 18, 1879.

INDEX.

A.

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O.

P.

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